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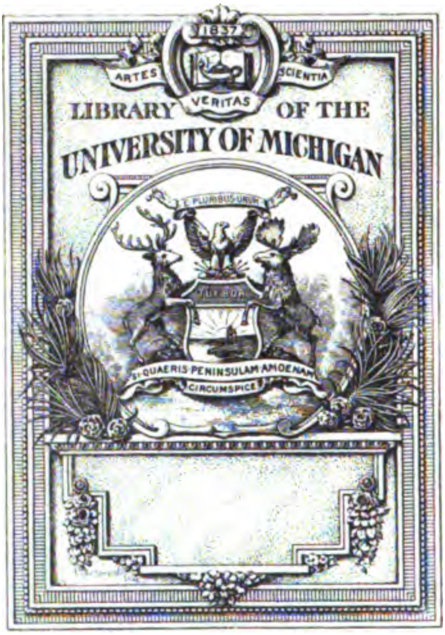
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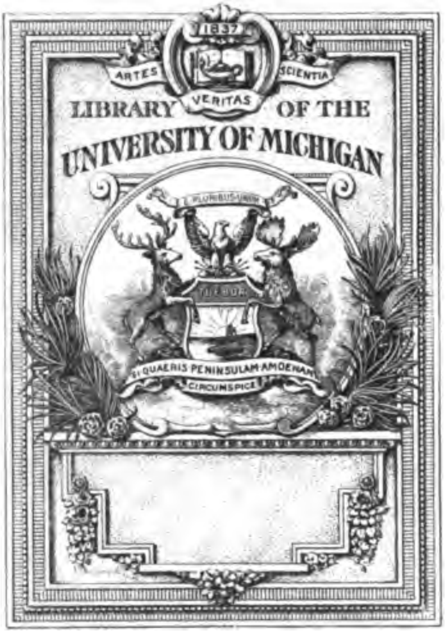
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A PRACTICAL TREATISE

ON THE

MANUFACTURE OF SOAPS.

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A PRACTICAL TREATISE

ON THE MANUFACTURE OF

SOAPS.

WITH

*NUMEROUS WOODCUTS AND ELABORATE
WORKING DRAWINGS.*

BY

CAMPBELL MORFIT, M.D., F.C.S.,

FORMERLY PROFESSOR OF APPLIED CHEMISTRY IN THE UNIVERSITY OF MARYLAND.

LONDON:
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Dedicated

TO

WILLIAM GOSSAGE, J.P., F.C.S.,

WHOSE PRACTICAL GENIUS HAS STIMULATED THE PROGRESS OF
MANY CHEMICAL ARTS.

PREFACE.

THIS is an original treatise founded upon the studies and labours of the author, in the industrial chemistry of fats. Its object is to reform the empiricism of soap-making, by adjusting the art to the principles of true and modern science.

The experimental results from which it is written were conducted on a manufacturing scale; and therefore both the text and the drawings may be accepted, with full confidence, as positive lessons in the theory and practice of the subject.

Later, when the feeble health of the author may have permitted the completion of the manuscript, he purposes to publish an auxiliary work, in this connection, upon COTTON SEED. As in the present instance, the precepts will be from actual experience and in detail, so that those who may undertake to carry them out will be able to do so understandingly and successfully.

Moreover, the system of operations, to be set forth, has been arranged for utilizing the seed through all of its possible derivatives, in a profitable sense, and by means which are accessible and inexpensive wherever cotton is cultivated.

LONDON,
May 9, 1871.

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THE
MANUFACTURE OF SOAPS.

CHAPTER I.

INTRODUCTION.

TRUE soap is a definite chemical compound of one or more fat acids with a base, and a certain ratio of water of constitution. Like any other true salt, in chemistry, it is constructed according to fixed laws, and therefore the art which regulates its proper manufacture belongs to the province of science. The empiricism which has attended the practice of the art of soap-making, hitherto, is due to an ignorance of the principles of the science which govern it, for few of its followers work understandingly in regard to them. Indeed, so uncertain is the uniformity of results by the usual methods of operating, that it seldom happens that any two batches of soap correspond throughout, however great may be the mere practical skill or experience of the manufacturer.

An art evolving products which bear so closely as soap upon the cleanliness and comfort of the human family, deserves the best consideration of the mind; and its followers should unite their labour with learning so as to work out results of elegance, as well as of utility and profits. The seeming incongruity between handicraft and a familiarity with the principles which it involves, would then be made to disappear; and the accomplished workman, in thus smoothing the pathway of progress, be enabled to illustrate, practically in his own career, the dignity of labour and the value of education.

The commercial position of the art is no less important than its scientific bearings, since the quantity of soap made and consumed is enormous. The product in Great Britain alone is upwards of one hundred and fifty thousand tons annually; and in the United States about an equal amount. In France, the total manufacture rises even higher than for either of those two countries just named, because, in addition to its large product of ordinary export and household soaps, it has a monopoly of the trade in olive oil and Marseilles soaps. Many single manufacturing houses in England, France, and the United States, send into the market as much as 100 tons per week. Indeed, Messrs. Gossage, of Widness, and some few other makers, turn out, severally, a product of 150 to 200 tons per week.

The present work will be restricted to thorough instructions in the more practical bearings of the acid derivatives of neutral fats upon the manufacture of soaps. Attention will be devoted, rather exclusively, to the preferable employment of "Crude Oleic Acid," "Olein," "Brown Oil," "Red Oil," and the fat acids generally, as soap stock, in place of tallow, palm oil, and kindred neutral fats. There are very many sound reasons for adopting this course. One of the more important is, that crude oleic fats, being secondary products in the manufacture of stearic candles, the clarification of oils, and the distillation of "oil foots" and "recovered grease," constitute an abundant and increasing resource of material for which there is only a limited demand, even at a much less price than that of tallow.

This abundance of supply and comparative cheapness arise from the circumstance, that outside of the wool-manufacturing trade, which consumes only a limited quantity, the market for crude oleic fats, particularly in England, is only moderately active. The fact is that soap manufacturers, working as they do at present, with few exceptions, "by rule of thumb," have not the skill which would enable them to adopt their old processes to the exigencies of a new material, however valuable, which may have properties strange to their mode of management. Moreover, oleic fats are wholly unsuited fòr the purpose of illumination and lubrication.

Yet such are the great advantages for soaps which these materials possess, alike on the score of economy and superiority of product, that sooner or later they must become the prevailing soap stock of the world. So rapidly progressive is the consumption of candles by reason of the advance of civilization in new and distant countries, and of the opening of fresh mines, that all the more consistent neutral fats, such as tallow, palm oil, cocoa nut oil, and the like, will be monopolized ere long for the manufacture of stearic candles. This extension of a single industry, therefore, will augment the supply of crude oleic acid in a very important degree.

Moreover, resort to oils being thus also enforced as to many other purposes than soap-making, for which tallow is now preferred, there will be, consequently, a large accession to the present abundant supply of "oil foots," resulting from the clarification of the crude oils. This in turn will enlarge, necessarily, the production of oleic fats by distillation.

Now, when it is considered that the supply of these crude oleic fats will continue always in advance of the demand for them, and that, moreover, on account of their narrow circle of industrial application, their market price will lag ever behind that of tallow, it is very obvious that a new vein of wealth, without end or fault, has been struck for the soap manufacturers. This vein is all the more rich because the limited application of the crude oleic fats will prevent them rising in price even proportionately with tallow; and consequently the use of them becomes more profitable and most opportunely when tallow and kindred neutral fats may be scarce or dear.

This is especially the case in view of those recently devised means by which the neutral fats may be rapidly and cheaply converted into fat acids.

The counter current in the commercial flow of tallow and oleic fats already existing, and gathering force daily, is driving the soap manufacturer, slowly but surely, into a critical position; therefore he should make a diversion, while he may, into that smoother stream running at the side which is visible to even a moderate discernment. Indeed, the oleic fats have already established their superiority as soap-stock in France, Belgium, Austria, Russia, Germany, Italy, and Spain. The use of them has become general for all kinds of soap, except that particular kind made from a mixture of olive, sesame, arachide, and other fat oils, known as Marseilles or Castile soap. Here in England, on the other hand, the soaps made from tallow, kitchen grease, and rosin, still prevail, except for the purposes of the woollen and silk manufacturers; while in the United States both neutral and oleic fats find places in the soap manufacture.

Throughout all these countries, however, the method by which oleic fats are made into soap is some one or other empirical modification of the old boiling processes; so that there is little uniformity of results, and consequently oleic soaps vary in character and appearance with the factory from which they may have come.

Nevertheless, so excellent are the fat acids for the manufacture of soaps, that let them be converted by no matter what process, they will give products far superior to those from neutral fats under the most skilful management.

But to develope all their valuable qualities in the maximum degree, they must be worked by a method adapted specially to them; and thus the resulting soap will be not only excellent beyond comparison, but even less costly than the best of any other kind.

Foreseeing the necessity of such a method some eight years ago, I set myself assiduously to the task of constructing it, and in this treatise present the successful results of my costly, tedious, and anxious labours. The subject having been studied, practically, through all its ramifications, I am thus enabled to show the way even for creating a direct source of crude oleic fats in cotton seed whenever the emergency may arise. Indeed, so inexhaustible is the supply of this raw seed material, and such are the facilities for converting it into oleic fats and other valuable products, even at its place of growth, that it would be expedient now to bring it into the service of the soap manufacturer to the entire exclusion of tallow and other neutral fats.

The use of these cotton oleic fats in connection with the author's system for the manufacture of soap, would insure an economical product of great purity at a cost no greater than that of those soaps which are made of neutral fats and such cheapening admixtures as rosin, silicate of soda, sulphate of soda, hyposulphite of soda, clay, and water. These latter are all diluents at best, and when present in excess, as is often the case, constitute a fraud upon the consumer.

Some shipping soaps are so overloaded with water that they lose often forty to sixty per cent. of their original weight during the voyage of transportation, and therefore carry disappointment and a loss of freight money upon evanescent goods.

There is no justification for the use of such expedients to meet the exigencies of competitive trade, when an honest material and ample instruction are at hand for the manufacture of a pure soap at a sufficiently large profit.

Chevreul, Pelouze, Fremy, in elucidating the practical chemistry of fats, and Leblanc and Gossage in creating an economical soda material of easy management, have contributed their unselfish labours in vain if the soap-maker heeds not the finger-posts in the pathway of progress which their successful studies have set up for his guidance. The learning which they have generously bestowed is a trust to be administered and spread about for the general good. As faithful stewards, then, all the followers of this art should recognize their just obligations, to work conscientiously as well as with knowledge, and to be ever prompt to admit their fellow-labourers and the public to a share of whatever advantage their genius, their studies, or application may accomplish.

Thus will be established that mutuality of interest between producer and consumer, which is the most solid basis of all honourable industries of profit. And in this way, too, the manufacture of soap will be made to rise high above the level of mere handicraft, and to assume the precision of a truly chemical art.

CHAPTER II.

THE PRINCIPLES OF THE SYSTEM.

THERE are four cardinal principles upon which this system is founded, and they are believed to be wholly new and original.

1. The saponification of the fat acids generally, whether singly, or intermixed among themselves, or with rosin, and their conversion into soap by means of alkaline carbonates, either with or without the direct use of water.

2. The management of the water of constitution of the soap in a manner quasi-chemical, by which it is made, comparatively, a permanent ingredient.

3. The use of carbonate of soda of different

degrees of hydration, as a means of apportioning the water and alkali in the soap.

4. The instantaneous manufacture of soap, hard and soft, without the use of caustic leys, and upon a definite plan by which the amount and composition of the product may be deduced in advance from the quantity of the materials employed.

This system of making oleic soaps had its inception with me in 1856,* at which period the "*sal soda*" ($NaO, CO_2, 10HO$) was used in a *powdered* state; the ratio of alkali and water being adjusted by the partial employment of *sal soda*, in an effloresced or semi-dehydrated state ($NaO, CO_2, 5HO$), and soda ash. This involved the necessity of considerable apparatus and space, which disadvantages were obviated by an important improvement that suggested itself to me in

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* See Letters-Patent of the United States, No. 154,321, July 29th, 1856; and No. 19,667, March 16th, 1858; also Letters-Patent of Great Britain, No. 588, March 20th, 1858.

1860. This improvement consisted in *fusing* the *sal soda* in *its own water of crystallization* instead of powdering it, a very simple and inexpensive operation, which reduces the salt to the necessary state of mechanical division.*

England being the soda-producing country of the world, it became necessary, for the introduction of my system into foreign countries, that the expense of transportation and import duties upon the large proportion of water (63·0 per cent.) in sal soda should be avoided. This is now done by the substitution of a dry, wholly carbonated fine ash, of very high strength, *dissolved* at the moment of use in a quantity of water sufficient to convert it extemporaneously into sal soda, or a lower hydrate of carbonate soda. Thus the advantages of the system are radically improved in an economical sense; for not only is the cost of alkali lessened here and abroad by this important change, but the process itself is greatly simplified, and the system carried far out of reach of any competition. This last improvement was made by me in 1865. It does away with the necessity of using any other alkali material, in connection with the liquid sal soda, to make the requisite adjustment of the ratios of soda and water in the soap; since any quantity of water may be taken as required.

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* See Letters-Patent of Great Britain, No. 2,863, November 13th, 1861.

In addition many simplifications of the details of the manufacturing operations have been made during the experiments of the past six years at the factories established in France and London for the purpose.

Moreover, a new, abundant, and economical source of fat acids, from the distillation of cotton oil and other similar "foots," is now made subservient to this system with great advantages both as to the cost and quality of the soaps.

Furthermore, an economical method of refining crude cotton-seed oil into superior fat acid products for my system of soap-making has been recently and practically worked out by me. So greatly have these combined improvements changed the character of the original method, that the system may now take rank as the best application of science in the art of making soap.

The advantages of the system may be enumerated as follows:

1. It utilizes with great advantage all the various kinds of crude fatty acids, and more particularly the crude oleic acid ("*Red Oil,*" "*Brown Oil,*" or "*Olein,*" of commerce) which constitute a secondary product in the manufacture of stearic candles, and in the distillation and pressing of oil "foots" and "recovered grease." These fats are abundant in most markets at prices much lower than that of tallow, palm oil, tallow oil, or other neutral

fats, on account of their being unsuitable for illumination or lubrication.

2. It requires for its exploitation only a tenth of the space and time occupied by the ordinary methods of making soap, and is worked with a plant of moderate extent and cost, compared to the amount of soap produced.

3. It produces the soap with the greatest rapidity and least possible outlay of labour and fuel. From the time that the oil and ash enter their respective pans to the moment when the finished paste is to be shovelled into the cooling frames, there is only an interval of two-and-a-half hours. Two days thereafter, or less, the soap is hard, and ready to be cut and sent into market. Four boilings, or cuites, may be made, therefore, per day in each soap-pan.

4. It saves the necessity of keeping a stock of soap on hand to supply sudden demands or contracts, and thus requires but a moderate

capital for its exploitation, and consequently saves interest largely.

5. It delivers the soap hard at once, and containing any high proportion of fat and low proportion of water that may be required, without the necessity of subsequent drying out for the purpose.

6. It gives soaps always of uniformity as to kinds, and which are very mild to the skin even when containing an excess of alkali.

7. It gives soaps which are always hard and clean in the handling, and do not shrink or lose water and weight by exposure.

8. Its operations are most simple, and always under control, so that it is impossible to spoil a batch. There are no spent leys or waste product, and the amount and composition of a batch may be deduced in advance with great precision from the known composition and proportions of the materials.

9. While this system offers every facility

for "*running down*" pure soap, that is, for making it into cheap sorts by the introduction of excessive water or of adulterating materials, it does not, in its integrity, contemplate any such degradation. On the contrary, it is designed to furnish soap of the greatest possible excellence at the lowest possible cost, so that the manufacturer may have a creditable means of securing both profit and success against the dishonest competition of very much inferior soaps as made by the older methods.

10. That it utilizes most advantageously a fat stock superior to the neutral fats, such as tallow, palm oil, and the like, however skilfully, or by whatever method the latter may be converted into soaps; for the soaps produced by the fat acids have the distinguishing characteristic of greater cleansing power combined with a durability in the wash water, and a mildness to the skin, that cannot be obtained from any other kind of soap stock.

Moreover, fat acids, being already freed of glycerin, they save all loss from the unavoidable waste of that substance in the use of neutral fats, and amounting to about six per cent. of the cost price.

11. It gives soaps which wear away quite slowly, yet lather and cleanse well, in both cold and hot water.

12. Finally, it does away with the expense of lime, and is free from all the waste, dirt, delay, and inconvenience of converting the soda ash into *caustic leys*, as required for the usual method of manufacturing soap.

CHAPTER III.

THE RAW MATERIALS.

THE raw materials which form the basis of this system are the fat acids generally, and carbonated soda ash. As accessories in the manufacture of certain kinds of soap, crystallized carbonate of soda, or "sal soda," and glycerin, may be employed. Rosin is used sometimes as a diluent to lessen the cost of the soap, and also in small quantities to prevent any tendency to efflorescence.

Fat Acids.

All the fat acids, of whatever kind, are suitable for this system, it being immaterial how they may have been made; but some are more advantageous than others; for example, those fluid ones which contain the most solid fat give the harder and more durable soaps.

Specific gravity is not an infallible means of determining the degree of comparative superiority, for often a thin oleic acid from one source will have the density of a thicker one, made by some other process, from some different material. It would seem, however, as a general rule, that the higher the specific gravity of the fat, the denser will be the soap made from it. The congealing point in the case of fluid fat, or the fusing point in that of the more consistent fat acids, is the chief distinguishing feature. As a rule, the sooner a fluid fat acid congeals the better it is as a soap stock.

Fat acids obtained by the action of superheated steam upon neutral fats are nearly free from any perceptible odour; while those produced by lime saponification have somewhat the smell of slightly rancid tallow. The products of distillation with sulphuric acid, on the other hand, have often a very decided and characteristic odour, sometimes empyreumatic, and at others, as in the case of "recovered grease" and its distillates, assimilating to that musty smell given off, in washing, by cocoa-nut oil soaps.

When the oleic fat may have been produced by distillation with the minimum of sulphuric acid, its empyreumatic odour is so slight that it becomes perceptible only when a portion is rubbed under the finger on the palm of the hand. The fat acids produced by my system of refining cotton oil have rather a pleasant smell.

All crude oleic fats are very much less costly than tallow, palm oil and other neutral fats, being mostly secondary or by products from other manufactures.

In almost every respect the fat acids give better practical soaps than the neutral fats, particularly when converted by this system. The oleic soaps made as herein directed, combine durability with solubility, which is an all-important quality for the purposes of the silk and cloth manufacturers. Moreover, even when they may contain an excess of alkali, any injurious effect on this account is prevented by the soap breaking up into new compounds of fat acid and alkali in the presence of water. They thus produce a great and characteristic emollient effect upon the goods and skin without any lessening of their eminent detergent power. And it is remarkable that my oleic soaps cleanse better in *cold* and *hard* waters than the highest grade of soap that can be made from neutral fats. Indeed, for most purposes, it is not necessary to use hot or even warm water for bringing out their best effects. It should be mentioned, however, that in case any chlorine or hydrochloric acid may have been used in the production of the fat acids, these latter then give soaps rather defective in solubility and suds property.

A convenient and simple way of testing the comparative soap value of oleic fats is as follows. Provide a beaker glass, E (Fig. 2), of about five inches height and three inches diameter, a test tube, B, of about eight inches height and one inch diameter, and two thermometers, C and D, with enamelled scales of corresponding accuracy, Fig. 1.

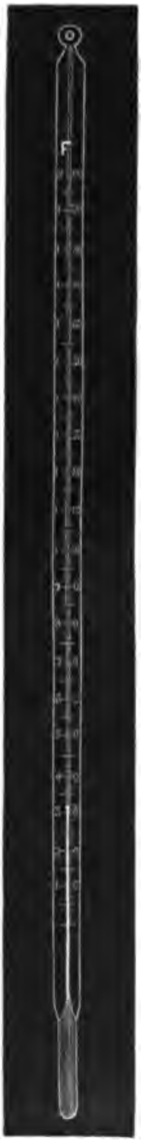


Fig. 1.

Fill the beaker with water to the line A, and the test tube, with the fat under test, to the line B. Then, by means of a perforated cork, fitting the mouth of the test tube loosely, sink a thermometer into the fat to within a quarter inch of the bottom. This test tube is next placed by similar means in the beaker, E, with a second thermometer perpendicular to it, and an inch distant, as shown by D. If the fat acid under test is more or less solid, the apparatus as arranged is set upon a sand bath over a

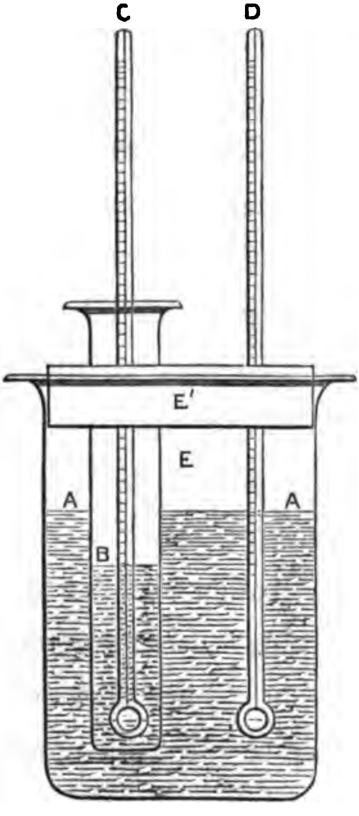


Fig. 2.

gas flame, and gradually heated. As a general rule, the outer thermometer, D, keeps about 5° in advance of that in the fat so long as the apparatus remains in the bath; therefore it must be removed from time to time in order to equalize the temperature of the fat and water as nearly as possible. Neither thermometers nor tubes should touch the sides of the containing vessels.

By keeping the eye constantly on the operation, the exact moment can be observed at which the fat begins to melt, and that is its fusing point. This is to be taken, however, as the mean between the degrees shown by the inner and outer thermometers, where the difference is only slight, as it should be when the experiment is carefully conducted. For example, if C has at the instant 117°, and D has risen to 119° Fahr., the melting point of the fat may be noted as 118° Fahr.

In like manner, if the fat under test is fluid, then proceed by placing the apparatus in ordinary water instead of on the sand bath, gradually cool it with colder water until the congelation of the fat fairly commences, and note the degree accordingly as above directed.

The point or degree at which the commercial "olein," or fat acid, commences to cloud and thicken, ranges from 32° to 75° Fahr., according to its source and mode of preparation.

Oleic acid may contain water, and as this presence causes loss of time and some sputtering during the heating operation, it should not escape observation when supplies are being purchased. It may be detected by heating a small portion of the oleic acid in a test tube to 160° Fahr., and leaving to repose until cool. If there is any quantity of contained water it will subside and show itself as a substratum. The better way is to put a given weight of the suspected oil in a small beaker glass of an ounce capacity and known weight, and heat to 212° Fahr. on a sand bath. If vapours rise and condense on the sides of the glass above the oil, they indicate the presence of water; and by further heating until all the vapours disappear, and then reweighing the beaker and contents when cool, the loss, if any, that is, the difference between the first and last weights, will represent the amount of water contained in the oil.

"Spirit oil" is another contaminating agent often present in those oleins obtained by sulphuric acid distillation, especially from cotton oil "foots." It is dissipated during the heating, and not only thus makes a loss, but sometimes also during saponification causes a violent intumescence in the pan, which endangers the overrunning of the contents. Heat a sample of the olein in a test tube, and it will give off a volatile, pungent, somewhat inflammable vapour at a temperature of 260° Fahr. if any spirit oil is present.

Rosin oil, if present, may be detected by its smell.

If it should be desired to take the specific gravity of a sample of olein, that is easily done by filling a glass bottle of the capacity of 250 grains of distilled water, carefully stopping it so that no air bubbles or spaces may be left in the oil or the neck, and then weighing it with precision. Bottles graduated for this purpose, and with an accompanying counterpoise weight, are sold by the dealers in chemical apparatus.

Supposing that the bottle of 250 grains capacity of distilled water, when filled with oleic acid, should weigh 225·75, then the specific gravity is $225{\cdot}75 \times 4 = {\cdot}903$, or the average density of crude oleic acid.

Oleic Acid from clean neutral Fats, such as Tallow, Palm Oil, &c.

The first kind to be considered, on account of its elder origin, is the crude oleic acid known commercially as "Olein," "Red Oil," "Brown Oil," and which forms the fluid secondary product in the manufacture of stearic candles. The supply is generally abundant, and at a price much less than that of clean neutral fats; though sometimes an excessive demand for it on the part of the manufacturers of woollen goods, in very active seasons of business, causes a temporary irregularity in these respects. The wool greasers are the principal, if not the only, competitors with the soap makers for this article.

Olein is made mostly by saponifying the neutral fats with lime, or distilling them with sulphuric acid. In the first case it is called "saponified oil," and in the latter "distilled oil." The former is a rather better soap stock than the distilled oil, for it gives a product which is prompt in hardening, and free from empyreumatic odour and yellow colour.

There is also an "oleic acid *foots*," or the mushy part of the "olein" strained from the fluid portion. As it is more consistent, it yields a soap somewhat harder than that from "red oil."

The white "foots" from the decomposition of tallow by super-heated steam, without the aid of acid or lime, is an excellent, inodorous fat stock for toilet soaps. For this same reason of consistence, stearic, palmitic, and similar fat acids, give very hard soaps but of inferior suds quality.

There is yet another oleic acid assimilating closely in external as well as internal properties to the "saponified oil." It is made by decomposing the neutral fats with sulphuric acid, as in the first step for the manufacture of stearic candles, and then decolorizing by means of bi-chromate of potassa, or other oxidizing agents. The sample from which the experience of the author is derived was obtained from the factory of Professor Brock, Copenhagen.

The manufacture of this kind of oleic acid and other fat acids, will be fully described in the author's forthcoming treatise on "*Cotton Seed and its Derivatives.*"

The "oleins" of France and Belgium do not differ materially from those of England and the United States, to which the preceding remarks more particularly refer; except, perhaps, that those made in the former countries by sulphuric acid distillation, have rather more empyreumatic odour. In France, however, the greater part of the candle oleic acid is produced by lime saponification; whereas in Belgium the method of manufacture by sulphuric acid distillation is almost universally followed. The lime processes in open vats as well as under pressure in autoclaves with the concurrence of steam, and also that of sulphuric acid distillation, are about equally followed in the United States. In Denmark, the simple, sulphuric acid saponification process prevails.

The market price for "olein," or crude oleic acid, is always much less than that of tallow, and generally also below that of "tallow oil," which is the olein proper, running from tallow when that fat is granulated and pressed for conversion into "summer tallow candles." As a general rule, the higher the price of tallow rises, the lower, proportionately, becomes that of "olein." In other words, the abundant supply of crude oleic acid, and its restricted applications, prevent it keeping pace in market value with any neutral fat.

None of the fat acids contain glycerine, and they are thus also more profitable as soap stock than neutral fats.

Fat Acids from Cotton Oil Foots.

Crude cotton oil, as pressed from the seeds of the plant (the several species of *Gossypium*), is thick, gummy, and greenish black. These impurities are in lesser proportion.

when the oil has been manufactured from hulled seed. The oil is treated usually with an aqueous solution of potash or soda for the removal of these impurities. Then two strata are formed,—an upper, consisting of clarified oil, which is sold for mixing with olive, rape, and other oils; and a lower, carrying down the foreign matters in combination with potassa. More or less of the oil is also involved with the latter, according to the skill employed in the clarifying process.

The lower stratum is technically known as "cotton oil foots," and has a commercial value for the potash and fat which it contains. To separate these it is treated with oil of vitriol and water, which unite with the potash and form an aqueous solution of sulphate of potash. This being drawn off there remains only the "foots" proper.

On distilling these latter there passes over a dark green distillate, which, on cooling, is a fat-acid, damp, mealy, concrete mass, with a fusing point of about 102° to 105° Fahr., and specific gravity of ·856.

If this is cold pressed there runs out a dark green oleic fat, which congeals at 55° to 60° Fahr., while the remaining cake of the same colour, but very many shades lighter, has a fusing point of about 115° Fahr.

This cake, by further distillations and pressings, loses its dark colour and becomes material of higher melting points, as shown by Nos. 28 and 30 in the annexed Table.

These cake fats give soaps of great emolliency, and are very serviceable materials for stiffening fluid fat acids, when the latter are to be used in the manufacture of special kinds of soaps, as will be explained hereafter in the formulæ. They sometimes retain a little of the original empyreumatic odour, which, however, disappears by time and exposure, and may even be promptly removed by melting them, and running jets of steam into the hot fluid mass for several hours.

First or Normal Oil.

The dark green oil (No. 19) expressed from the mealy distillate, is not only the cheapest, but one of the best fat stocks for soap purposes that can be obtained, provided no hydrochloric acid has been used in its production. The odour and colour are its sole defects, and these disappear in great degree when it is made into soap by my system. Indeed, I have observed that the soap from this oleic fat bleaches in a few weeks from an olive to an olive drab shade, and retains very little of empyreumatic odour. For my purposes generally it must be subjected, however, to distillation; but as I shall prescribe the use of this normal oil, advantageously in certain formulæ for soaps adapted to particular uses and markets, it is proper to give also the method by which to refine it as may be desired. The mode of treatment will apply equally well to this dark green fat, either before or after pressure, and also to the recovered grease. Its action, however, is more of a deodorizing than a bleaching character, as it only changes the green colour into a less objectionable brown.

Procure a wooden or lead-lined vat of 300 gallons capacity, and the form of an inverted cone, with a cock and a tube twelve inches long at the apex of the cone; and arrange it firmly in a frame. One ton of fat is to be put into this vessel, with about five gallons of water, and brought to 190° Fahr. by a current of wet steam entering the oil through a tube, or tubular stirrer, made of lead. At this temperature, but not sooner, eighteen pounds of nitric acid, of specific gravity 1·373, are added portionwise, and the steaming continued until the temperature reaches 200° to 205° Fahr. As soon as a drop of the fat, taken out and put on a piece of white porcelain, shows a brown colour in place of its original blackish green, the addition of acid and the steaming must be arrested; otherwise the chemical action will next extend to the fat, and impart to it an elaidic modification, whereas the object is to restrict it wholly to the colouring matter.

When the brown colour is attained the steaming is stopped, and the fat allowed repose for ten minutes, so that the subsident acid water may be drawn off through the cock below and reserved in a carboy. Ten gallons of fresh water are now added to the oil and the whole brought to boiling by steam; and again, after ten minutes repose, the subsident water is drawn off through the cock below as waste. The oil is washed again and again in the same manner with two relays of fresh water. It is then clean, much freer of pungent empyreumatic odour, and ready for use.

The acid at first drawn off may serve for a new batch of oil. In that case, as it is already diluted, there must be no addition of water to the oil over and above that accruing from condensation of steam.

Cotton "oleins" lose very little of their odour by this nitric acid treatment. Moreover, after this action of nitric acid they give soaps of lesser firmness and deeper colour.

"Recovered grease" and its "oleins," on the contrary, are improved both in colour and odour by this treatment, and they then also yield a better smelling soap—somewhat less hard than previously,—but of rather greater suds property.

The treatment with bi-chromate of potassa, as will be described in my treatise on "*Cotton Seeds and its Derivatives,*" may very advantageously be substituted for that with nitric acid. Though more expensive, it does not impair the natural property of the "oleins" for making soaps of superior hardness and *emolliency.*

The term "oleins" here refers to crude oleic fats. This green, cotton "olein" gives *very superior* washing soap both as regards emolliency and cleansing properties.

Distilled Cotton "Olein."

This oleic fat, designated as No. 13 in the annexed Table, is of very variable density and congealing point, but always superior as a fat stock for manufacturers' soap made by my system. It is obtained from the normal oil (No. 19) by redistillation, which changes its colour to a light brown and modifies its odour. By the injection of steam currents for several hours into the oil exposed in an open vat, the odour of the latter may be further removed. As this oil is employed only for manufacturers' soap its odour is not a serious objection to it. That being wholly removed, the olein would become then a most excellent material for household soaps. It should be remarked, however, that every distillation of an oil changes more or less of it into a pitchy residue of little or no marketable value at present, and, therefore, the cost of the oily acid increases with every successive treatment of this kind. As a general rule also, the consistency of the fat is thus increased, and its colour lightened until, by a third distillation, it becomes white and firm like lard, as represented by No. 17 in the Table. The empyreumatic odour of the latter is, however, more intense and persistent than that of the normal and "distilled olein" from which it is made. It is objectionable as a stock for toilet soaps, though comparatively cheap, and gives a hard white soap. Better soap results can be obtained by the use of mixtures of deodorized cotton fat cake and inodorous oleic acid, as made at the works of Price's Candle Company, Limited, London, and certain candle factories of the United States and Denmark.

The distilled "olein" is also one of the best and cheapest fat stocks to be obtained, particularly for my system of manufacturing soaps for the wool and silk trades.

Morfit's Oleic Fats.

All the various kinds of oleic acid or "olein" offered in the market have been deprived as much as possible of stearic or solid portion. Being thin, consequently, the soaps made from them must be concentrated until they contain as much as 65 to 70 per cent. of fat, in order to assure the properties of hardness as well as of slow wearing in the wash waters. Moreover, their density, consistence, colour, and smell vary with the original material from which they may have been derived, and the mode of their production. Then again, the "olein" from the candle manufactories is a favourite kind with makers of soap by the ordinary processes, being used as a diluent for tallow to cheapen the cost of the soap and improve its properties. Though still of much lower cost than tallow or palm oil it is yet dearer than the ordinary cotton "oleins." These latter, though they give soap of remarkable emolliency, have, on the other hand, a disagreeable odour which renders them unsuitable for *household or general soaps;* and are so thin that even for milling soaps they must be stiffened with a certain portion of solid fat acid or cotton fat cake.

To secure an independence of all these defects and contingencies, as well as uniformity, and at the same time the very great advantages of a monopoly in a Cotton Oil Soap Stock, I have worked out a process for producing the fat acids, Nos. 24, 25, and 31, in the Table. As to intrinsic qualities neither leaves anything to be desired, though one is brownish and is restricted to the manufacture of Windsor dark toilet and manufacturing soaps. The others being nearly white, will give superior household soaps. Neither has any unpleasant odour, and that little smell which characterizes them may be completely neutralized by the addition of a little rosin. Indeed, as these fats contain all their natural solid portion, they will bear a liberal rosin admixture, to the advantage of great profit, and without any depreciating effects in other respects. They are the best and cheapest fat stock that can be made for any system of soap-making, but more particularly for that now under description. The mode by which they are manufactured will be set forth in my forthcoming treatise on "Cotton Seed and its Derivatives," and the means prescribed will be accessible in any country, however remote, in which cotton seeds are harvested.

Yorkshire Grease.

This is a dark-brown, granular fat acid, of the consistence of hard butter, and marked No. 20 in the Table. It is obtained from the suds and soapy waters of laundries, wool, silk, and other manufactories, the consumption of soap in these quarters being so great as to render this process of economy very profitable. Some operators concentrate the waters by heat and then add acid to neutralize the alkali and send the fat to the surface as a separate stratum.

Lister uses revolving discs for the purpose, and these, being partly immersed in the soap suds, take up in their revolutions thin films of liquid, which are acted upon by streams of air to promote the evaporation.

The sticky nature of the grease, its variable content of foreign matters, and peculiar musty odour, prevent its finding favour with soap makers; and therefore, notwithstanding its low price—less than one-half that of tallow and more than one-third less than that of cotton olein (No. 13 in the Table)—it is often a comparative drug in the market.

It has another fault, that it gives soap deficient in solubility. I have also observed this peculiarity in occasional samples of the cotton foots distillate (No. 18 of the Table). The cause of this fault is inexplicable at present, though it most probably arises from some one or other of the materials used in its preparation. The action of hydrochloric acid will produce it under certain circumstances. McDougall attributes this defect to the presence of more or less of neutral fat which has escaped decomposition ; and, acting upon this idea, proposes to determine the suitableness of a "recovered fat acid grease," and particularly the solid pressed (cake) portions, by its perfect solubility in strong alcohol. If the sample under test should be imperfectly dissolved by the spirit, it will not make soap of good suds property, according to that chemist.

Owing to the extensive manufacture of soda in England, hydrochloric acid is almost a waste product incident thereto, and therefore of trifling cost, so that there is great temptation to substitute it on all possible occasions for sulphuric acid. It seems, however, to exert a very unfavourable action upon oleic fats, which are to be used as soap stock. Nevertheless, this Yorkshire grease gives, by my system, a very hard soap, which, when dissolved in water, jellifies quickly. It will carry a large mixture of rosin soap with great advantage to its suds and solubility properties. In fact its peculiarity, as above noted, renders the fat a very suitable mixture for more fluid oleic fats which might, alone, give soaps of excessive solubility. In *Afcli* and other formulæ hereafter given, I have prescribed how it may be used, with great profit to both manufacturer and consumer, in special cases. Its odour may be nearly destroyed by the action of nitric acid in the manner as prescribed at p. 39 for normal cotton olein. The addition of rosin has also the power of masking its odour in great degree.

Distillate from Recovered Grease.

This is No. 21 of the table and obtained by distilling recovered grease. It is a brownish-white granular distillate of less specific gravity than the preceding: but corresponding with it in all other properties and behaviour. It is one-third higher in price, and on that account not of important consideration as a soap stock for my system. When pressed it yields a solid portion to be converted into candle stock, and a fluid oleic fat (No. 23) called "cloth olein," used in the manufacture of woollen goods. This latter, unless mixed with a portion of cotton "olein" gives soaps which, though of good colour, are slightly sticky and wanting in hardness and solubility or suds property.

The cake or solid portion, when hot-pressed, serves as hardening ingredient for mixture with olein in the manufacture of toilet and cloth-milling soaps. It should, for these purposes, however, be wholly soluble in strong alcohol.

Rosin.

The rosin or colophony of commerce is the residue from the distillation of the turpentine balsam of the *pinus sylvestris* and other species of *pinus*.

In the soap manufacture it is used as a diluent of the fat stock to cheapen the cost of the product, but, nevertheless, when not in excessive proportion, it imparts some good qualities along with the disadvantages. It is both a convenient and economical material for the purpose.

Chemically considered it is a mixture of organic acids, and therefore acts towards alkali, in degree at least, like other acids. In this system, therefore, its behaviour corresponds with that of the fat acids, for practical purposes.

Rosin differs in its degree of transparency and brightness of colour from brown to amber. That which is most clear and of lightest shade is the best and most expensive quality. My remarks will refer more particularly to the amber-coloured rosin in general use among soap manufacturers. But they will apply closely also to the darker and cheaper varieties which may be more economically employed in the fabrication of soaps, with dark oils, such as the *Afcli* and the like. It has a specific gravity of 1·07 to 1·08 and melts at 255° to 275° F. alone, but much quicker in oil.

An addition of rosin to the fat acid, not exceeding five per cent., gives great smoothness and brilliancy to the soaps of this system, and at the same time checks any tendency to efflorescence from excess or impurities of alkali. Often as little as 2½ per cent. will produce these effects; and, when the fat acid lacks consistence from deficiency of solid matter, this proportion should not be exceeded, otherwise the resulting soap will be wanting in firmness.

Rosin also improves the suds property of soap and masks any slight peculiarity of odour in the oleic fat. It should never be used for manufacturers' soaps, except in the single instance of Nottingham lace soap, the purposes of which require a large admixture of rosin.

To the extent of 5 per cent. it may be managed in the formulæ by simply adding it to the oil at the commencement of the process and stirring the mixture well just previous to letting in the alkali. Beyond that proportion it must be saponified separately as directed, under rosin soap; and then mixed as pure rosin soap in proper ratio with the oil fat soaps, according to the rules set down in the respective formulæ which prescribe its use.

Nearly all household soaps contain rosin, and the popular prejudice in favour of the peculiar scent which it imparts, requires that all competing soaps shall conform to this arbitrary taste in this one particular, however better they might be in other respects without the admixture.

My cotton fat stock, No. 31 of the following table, is peculiarly adapted for taking up rosin advantageously, in the manufacture of soap from the former, and thus produces soaps very similar in external properties to the household or oilmen soaps but with great intrinsic superiority.

No.	Commercial Varieties of Fat-Acids and Rosin.	Colour.	Fusing or Congealing Point, Fahrenheit.	Specific Gravity at 62° F.
1	Oleic Acid, normal.........	Yellow white	20°	·898
2	Sebacic „ „	White	260°	·724
3	Palmitic „ „	„	137°	·965
4	Stearic „ „	„	158°	·884
5	Margaric „ „	„	140°	.
6	Palmitic Candle Cake	„	139°	·889
7	Stearic „ „	„	130°	·864
8	Mixed „ „	„	134°	·867

TABLE—*continued.*

No.	Commercial Varieties of Fat-Acids and Rosin.	Colour.	Fusing or Congealing Point, Fahrenheit.	Specific Gravity at 62° F.
9	"Red Oil" or "Brown Oil," by distillation from candle stock.	Light brown	58°	·902
10	" " "	"	52°	·908
11	" " "	"	55°	·901
12	" " "	"	53°	·903
12a	" " Simpson, Payne, & Co.'s.	"	44°	·897
13	" " from cotton oil foots.	"	56° to 70°	·894
14	" " by lime saponification from candle stock.	"	52°	·909
14a	Red Oil, by sulphuric acid decomposition, from Brock's works.	"	34°	·901
15	Brown Oleic Foots, by distillation from candle stock.	Dirty white	59°	·897
16	White " " "	White	75°	·891
17	Double-distilled Oleic Fat, from cotton oil foots.	White	70°	·900
18	First Distillate from cotton oil foots.	Dark green	102°	·856
19	First Distillate Oil "	"	55°	·907

TABLE—*continued.*

No.	Commercial Varieties of Fat-Acids and Rosin.	Colour.	Fusing or Congealing Point, Fahrenheit.	Specific Gravity at 62° F.
20	Yorkshire or "Recovered Grease," from the soap waters of factories.	Deep brown	88°	·947
21	"Distillate" from "Recovered Grease."	Brown white	90°	·901
22	Brown Oil from "Distillate" of "Recovered Grease."	Brown	48°	·912
23	"Cloth Olein" „ „	„	48°	
24	Morfit's: Fat Acid Stock from cotton oil (first fractional).	„	89°	
25	„ „ „ „ (second fractional).	Brown white	88°	
26	Hot-pressed Solid Cake, from cotton oil foots, by distillation.	Very white	142°	·885
27	Green „ No. B „	Brown green	115°	·871
28	Cold „ No. 1 „	White	124°	·908
29	„ „ No. 2 „	„	107°	·929
30	„ „ No. 3 „	Dark white	118°	·896
31	Morfit's third fractional Oleic Fat from cotton oil.	Dirty white	88°	
32	Rosin	Brown to amber.	255° to 275°	1·07

THE ALKALI.

An important point in the economy, convenience, and perfection of this system, is that the soda material shall be always of an uniform high quality and wholly carbonated. As little margin as possible should remain for the presence of foreign matters, or useless and even injurious salts, such as large proportions of chlorides and sulphates.

Carbonate of Soda.

Crystallized carbonate of soda or "*sal soda*" ($NaO, CO_2, 10 HO$), is composed in the one hundred parts of:

Soda	21·83
Carbonic Acid	15·37
Water	62·80

with some little chlorid of sodium and sulphate of soda, rendering it more or less impure. It is always to be melted in its water of crystallization and brought to boiling with a jet of wet steam before being added to the oil. The market price of "sal soda" is out of proportion to that of soda ash on account of the expense and waste in dissolving and crystallizing the latter into the former, after the manner adopted in the manufactories of soda products. Therefore, my experience has led me on the score of convenience and economy, to make it extemporaneously from a suitable soda ash. This is a valuable improvement upon the use of "sal soda," more especially in remote localities from England—the great centre of the soda manufacture—as it saves the transportation and customs charges on a very large weight of water. The process is very simple and consists merely in dissolving the soda ash in the proper equivalent of water and leaving it to settle. It is all-important, however, that the ash shall be wholly carbonated or nearly so, and contain as little as possible of chlorid of sodium. The presence of a greater quantity than 2 per cent. of this latter salt imparts a dead appearance to the soap, impairs its usual hardness, and renders it less durable in the wash water. This is particularly the case with soap made from distilled oil. Caustic soda in large quantity tends to produce similar defects, and injures the characteristic elegance of the soap. Sulphate of soda, on the contrary, improves the hardness and the colour of the soap without detracting from its intrinsic qualities of goodness, provided the quantity is not excessive.

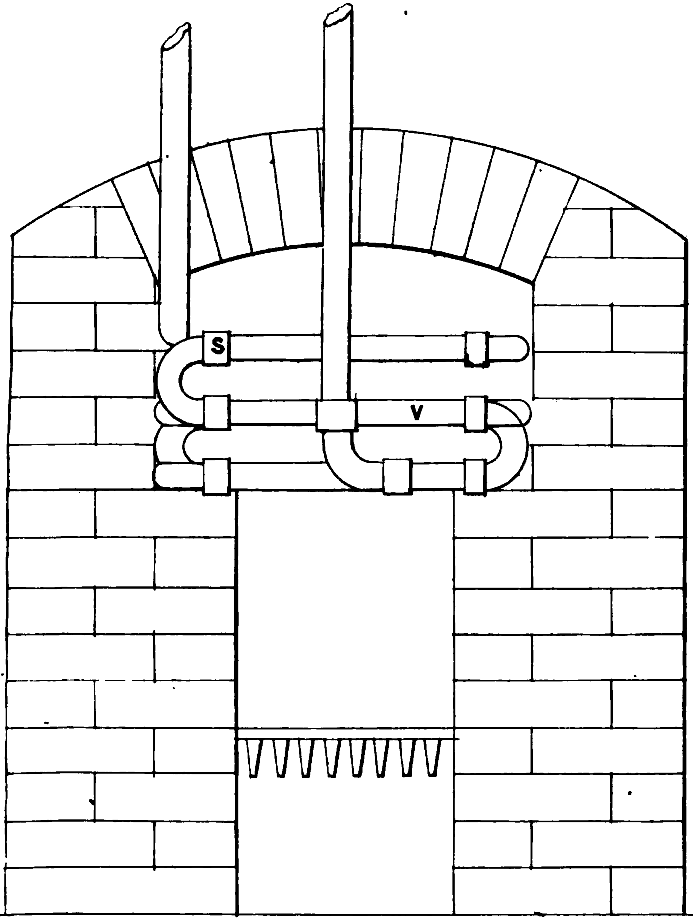
The Jarrow Company, Newcastle-upon-Tyne, England, makes a white ash, styled by them "*Jarrow Refined Ash of* 52°," which my long experience proves to be much better for the purposes of this system than any other maker's ash. It is uniformly of 52° caustic soda strength and contains little or no insoluble matter. Sometimes the proportions of chloride and sulphate vary. Its average composition is as follows:

Water	1·00
Sand and Silica	traces
Chlorid Sodium	2·84
Sulphate Soda	8·04
Carbonate Soda	88·66
	100·54

In ordering an invoice of ash let it be stipulated that it shall conform as nearly as possible to this formula; and always before using the ash subject it to chemical analysis according to the directions at pp. 63 to 71 of this chapter in order to determine its suitableness. At the same time ordinary ash will answer for this system, though with the inferiority of results just mentioned.

The soda ash above noted represents 88 per cent. of dry carbonate of soda. Therefore, to convert these 88 parts into fused "sal soda" it is simply necessary to dissolve them in the chemical equivalent of water. It thus becomes applicable to this system, which requires the use of crystallized carbonate of soda dissolved in its own water of

Plate 1.



SECTION

Specially designed for Dr. Morfit's Work on Soaps

constitution. The proportion of water is ninety pounds for every fifty-three pounds of dry carbonate of soda in a pure state: or in round numbers, and taking into consideration the foreign matters, 160 pounds (sixteen Imperial gallons) of water per 100 pounds of Jarrow ash.

The solution of ash is to be made in a wrought-iron vat lined with lead, so as to prevent the formation of oxide of iron and, consequently, the coloration of the liquor.

The solution of soda ash must always be allowed sufficient repose for the deposition of the contained dust and dirt: for, if it is used in a cloudy state, the soap will lack much of its natural good colour. The deposit or settlings must be removed from the vat, from time to time, as they accumulate. This precaution, however, is not indispensable in the case of *Afcli* and kindred soaps of deep colour, for common purposes.

The extreme quantity of caustic soda with which any oleic fat will combine is 13 per cent., and this only in rare instances and under circumstances inexplicable with my present knowledge of the subject. Beyond this proportion it will be present in the soap most certainly as a mere mixture. Indeed, for neutral soaps, it is never safe to employ a greater ratio of caustic soda than one-tenth the quantity of the oleic fat. At the same time there are soaps for certain purposes which require an excess of this proportion even though it may exist in the soap only as a mixture. There is one remarkable peculiarity, however, of the oleic soaps made by my system. It is that, even when containing an excess of alkali, they split up in the wash water into new compounds which, while very detergent, so regulate the action of the alkali as to prevent any injurious action to the goods, and even cause it to impart a soft agreeable sensation to the skin.

The soda is in a caustic or free state at the instant of combining with the fat acid to form soap, and to this end the ash must be converted previously into caustic leys for making soap by the usual methods. My system, on the contrary, sends the soda into action as carbonate to do the work of caustic leys even more quickly and efficiently, without the great trouble and expense of any preliminary treatment with lime. Therefore, to facilitate the calculations in constructing formulæ it must be here noted that 1·0 of caustic soda is equivalent to 1·70 of carbonate of soda and consequently requires 2·0 of Jarrow Ash (52°) to represent it. These figures refer to pounds or weights.

The mode of testing a sample of Soda Ash.

The sample is to be taken from the cask by boring into the centre of the latter with a try-auger. The portion of ash drawn out is then thoroughly mixed to produce uniformity, and a sufficient quantity put into a bottle for analysis and reserved sample. Fifty grains are to be weighed in a balance, Figure 3, then heated to redness in a platinum crucible and weighed again when cool. The loss indicates the amount of water contained in the ash.

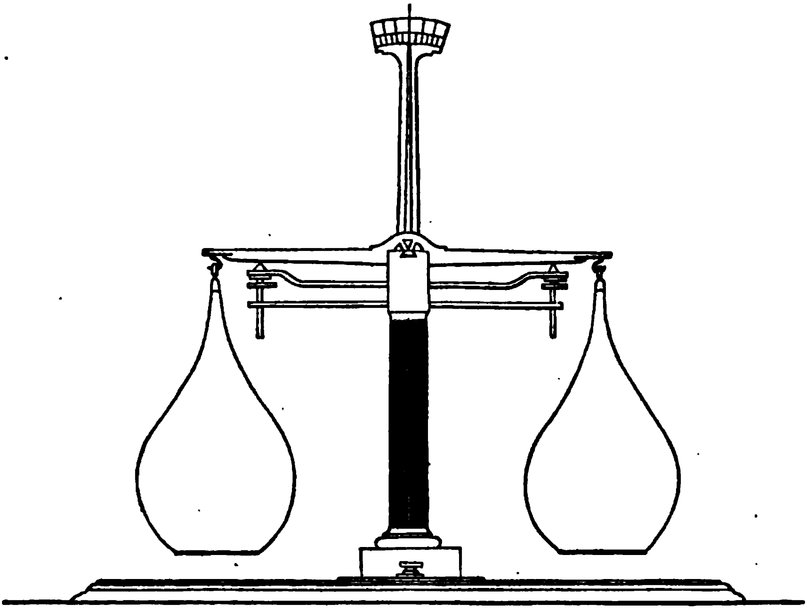


Fig. 3.

The dried residue is then to be emptied carefully into a small beaker glass and dissolved in hot water and filtered. The washed filter is next dried and calcined in a platinum crucible, as shown by figure 4, and weighed. When the filter has become wholly black or carbonized, the cover of the crucible must be removed during the remainder of the ignition

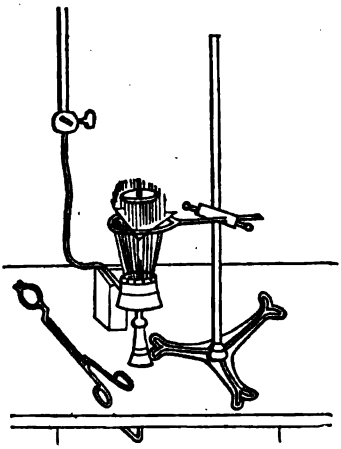


Fig. 4.

in order that air may enter. The weight gives the amount of the insoluble matters—sand, aluminia, &c.—in the ash.

The filtrate from the insoluble matters is to be treated gradually with normal acid liquor, preferably oxalic acid, until the litmus paper, used to test the approach of the point of neutralization, *retains a faint red colour when dried upon a platinum spatula over the flame of a lamp.* Care must be observed in noting this point of permanent redness; for the carbonic acid set free, and held by the liquor, imparts a temporary redness to the blue test-paper much in advance. The number of cubic centimetres, required to produce this permanent redness, or neutralization, indicates the per cent. of carbonate of soda in the ash. The normal liquor is employed in one of Mohr's graduated burettes with spring clamp, figures 5 and 6. Caustic soda 1·00 is equivalent to carbonate of soda 1·70.

Normal sulphuric acid liquor may be substituted for oxalic acid, but, owing to the variable quantity of water in the sulphuric acid of the shops with which the former is made, there is often a want of uniformity, consequently, in the test liquors of which it forms the basis.

Oxalic acid has the great advantage of

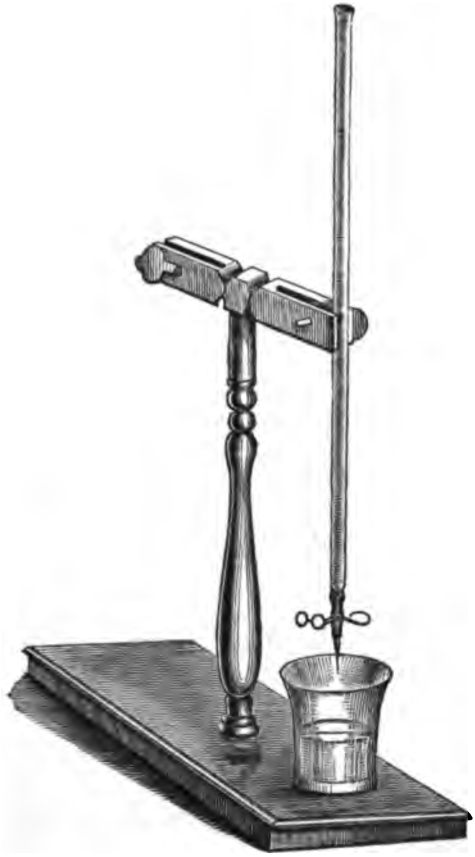


Fig. 5.

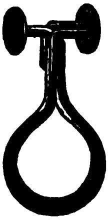


Fig. 6.

liberating the carbonic acid so slowly that the latter dissolves in the liquor at the instant of elimination without giving the sign of effervescence until saturation approaches with the gas, or, in other words, until the point of neutralization, or permanent redness, in the test paper is half reached.

To determine the amount of sulphate of soda, another 50 grains of the ash are to be weighed out, placed in a beaker, and boiled with excess of pure nitric acid, to neutralize carbonate of soda, and destroy or oxidize any sulphuret, as well as organic matters, that may be present. Distilled water is afterwards added for dilution, and next solution of nitrate of baryta in excess to precipitate the sulphate of baryta. The latter is filtered (as shown by fig. 7), washed, dried, and calcined in a platinum crucible, and weighed. Every grain of the calcined sulphate of baryta represents 0·609 grain of sulphate of soda.

The filtrate from the sulphate of baryta is next heated, and treated very carefully with the normal nitrate of silver liquor, just to that point when a precipitate or cloud ceases to be formed. The number of cubic centimetres of liquor consumed for this purpose indicates the number of half per cent. of chlorid sodium in the ash. Thus, if 50 grains require 1·20 cubic centimetre, then the per cent. of chlorid of sodium in the ash is quadruple, or ·60×4=2·40. One cubic centimetre of normal liquor of nitrate of silver must contain 1·47 grain of solid nitrate of silver to be equivalent to a half-grain (·50) of chlorid of sodium. Therefore this normal liquor is made simply by dissolving 1·470 grains of dry nitrate of silver in enough of

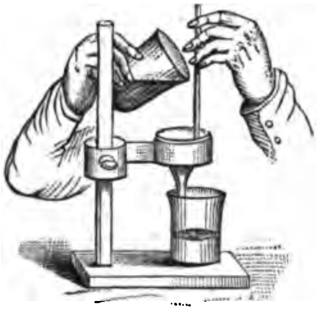


Fig. 7.

distilled water to make one litre at 60° to 62° Fahr.

If by accident there should be added an excess of the silver liquor, then the precipitated chlorid of silver must be filtered off upon a counterpoised paper, washed, and dried, until of constant weight, against the counterpoise paper similarly dried. This constant weight of chlorid of silver represents, for every grain, 0·407 grain of chlorid of sodium.

The water used for testing must always be distilled.

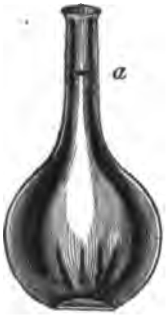


Fig. 8.

The normal oxalic liquor is made by putting 1182 grains of dry, pure crystallized oxalic acid in a flask (fig. 8) of one litre capacity (*a*), then adding hot distilled water, and heating to solution. Finally, cold distilled water is added until the liquor is increased in volume to 1000 cubic centimetres at 60° to 62° Fahr. In cold weather this liquor is apt to drop crystals, and therefore it is intended to be kept and used at a temperature of 60° to 62° Fahr.

If sulphuric acid should be used in place of oxalic acid, then, to make the normal liquor with the former, it is only necessary to weigh out 925 grains of commercial oil of vitriol, of 66° Beaumé, and dissolve them in distilled water sufficient to make the volume of 1000 cubic centimetres, or one litre.

The balance made and sold by Besson, Rue de la Ferronnerie, Paris, and shown by fig. 8, is recommended for its cheapness, accuracy, and general usefulness for laboratory purposes. It costs only 5*l.*, with its lantern and a box of fine grain weights from the same source; but much better from Oertling, Moorgate Street, London, may be bought for 3*l.* additional.

Silicate of Soda.

Formerly this material was used by me to replace partially the carbonate of soda in the saponification of the red oil, and the gelatinous silica thus eliminated and diffused through the soap imparts some very desirable physical properties. But there are offsets to this advantage in the inconveniences which accompany the boiling of the soap in a proper manner. Its use was continued, therefore, only during the earlier period of my invention; experience having proved that carbonate of soda alone, under judicious management, will give the best results with the greatest economy of time, labour, and money. If, however, it should be desired to use silicate in the preparation of any particular kind of soap, then it is necessary to have a dense solution of specific gravity 1·500, which will contain about 41 per cent. of solid silicate of soda. In this solid silicate the ratio of soda should not exceed 35° to 100° of silica, which is about the maximum proportion of the latter that can be gotten thus into a soluble silicate. Gossage & Sons, Widnes, near Liverpool, and Robert Rumney, Manchester, manufacture and sell a good quality at moderate price. That which I have used was from the latter, and had the following average composition, which is very suitable for this system:

Silica	29·14
Soda	11·26
Water	59·60
	100·00

Sulphate of Soda.

This material is sometimes used in small quantities for imparting hardness to soap; at others as a cheapening material for soaps of low grade; and also, in the one instance of "stripping soap" as an important element, for a special good and profitable effect to the advantage of the consumer.

The cheapest form of it is the "nitrate cake," forming the residue or "waste" in the manufacture of nitric acid from nitrate of soda. It always contains more or less of water and free sulphuric acid, the latter of which must be neutralized in order to bring the cake into proper condition for the purpose of this system. My experience proves that the average composition of the cake per cent. is as follows:—

Water	16·0
Free Sulphuric Acid	13·0
Sulphate of Soda	70·0
Iron, Aluminia, and dirt	1·0
	100·0

It would be almost as economical, and save much trouble in the manipulations, to substitute the dry sulphate of soda manufactured by the Jarrow Company, Newcastle-on-Tyne, England. Its price is only a little more than would be the cost of the nitrate cake, combined with that of the soda ash required to neutralize the free sulphuric acid of the former. The dry sulphate must not contain any appreciable quantity of chlorid of sodium.

Carbonate of Potassa.

This material, in the commercial forms of "pearl ash" or "potash," is to be substituted for soda ash in the fabrication of soft soaps, as potassa is the basis component of these latter in the same manner as soda is the basis element of hard soaps. This system is fully equal to the production of potassa soaps; but at this moment my practical experience in that connection does not extend far enough to enable me to give such directions in detail as will be in keeping with the thoroughly practical character of this treatise.

Carbonate of potassa is also the basis element of "Naples soap," and that form is used which has the commercial designations of "refined pearl ash" or "salt of tartar." It is so soluble in water that it even deliquesces on exposure to air. It contains less water of constitution than the chemically pure salt, as the following analytical table will show:—

PURE CARBONATE OF POTASSA. (KO, CO_2, + HO).	
Potassa	54·13
Carbonic Acid...	25·23
Water	20·64
	100·00

"REFINED PEARL ASH," OR "SALT OF TARTAR."	
Potassa	57·10
Carbonic Acid...	26·90
Water	16·00
Foreign Salts ...	?
	100·00

The "salt of tartar" is to be tested for strength in the manner as directed at p. 66, each cubic centimetre of the normal (oxalic) acid liquor neutralizing and representing 1·30 of carbonate of potassa or 0·885 caustic potassa.

Water.

Hard water gives the soap a dull exterior, and, therefore, it is better to use distilled water. To this end a reservoir must be provided for the condensation of the exhaust steam of the boiler and soap-pans. This reservoir should be of wrought iron galvanized, and so placed that the water may be conveniently drawn or pumped from it into the alkali-pan and feeders as may be required. It may be remarked here, that while water is indispensable to the constitution of soap, it is not in a strictly chemical sense a fixed component. It is rather a mechanical associate which can be almost wholly expelled by prolonged exposure of the soap to a heat of 212° F. For practical purposes, however, it may be considered as constitutional to the extent of 24 to 32 per cent.; and when soap will not, at ordinary temperatures of the atmosphere, retain the first-named proportion, then it is of defective quality.

Glycerine.

This substance is used in the manufacture of some kinds of toilet soaps. A very superior quality as to density, light colour, and general purity is made by F. Sarg, Vienna, and sold wholesale at the low price of eight to nine pence per pound. Price's Candle Company, London, also make glycerine of absolute purity, but its market price is comparatively high. Glycerine is not unfrequently adulterated with syrup or glucose. To detect them, it is only necessary to put five drops of the suspected glycerine in a test-tube, dilute with two fluid drachms of distilled water, add one drop of pure nitric acid and three or four centigrammes of molybdate of ammonia, and boil the mixture. The liquor becomes deep blue in two minutes, if any syrup or glucose is present. Pure glycerine should have a specific gravity of 1·252.

CHAPTER IV.

THE APPARATUS.

AN apparatus or plant for the convenient and economical manufacture of a daily product of three tons of soap and upwards, will consist of the following pieces. All the plates and figures in this chapter are drawn to a scale, and the letters of reference indicate the same parts in each and all of the plans of the battery.

1. A steam-boiler of 25 horse power, with an engine of 8 horse power. The boiler must be made of the best iron plates, and quite strong enough to be worked under a pressure of ten atmospheres.

In England, the recent Act of Parliament for the suppression of the smoke nuisance requires that every furnace shall be fitted with an arrangement for the consumption of its smoke. A simple and efficient one is that shown by figs. 9 and 10. The principle is that of the Argand burner, the furnace bars

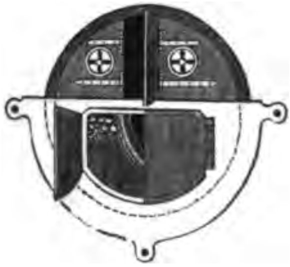


Fig. 9.

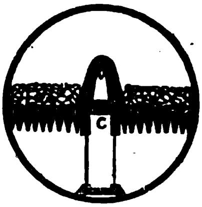


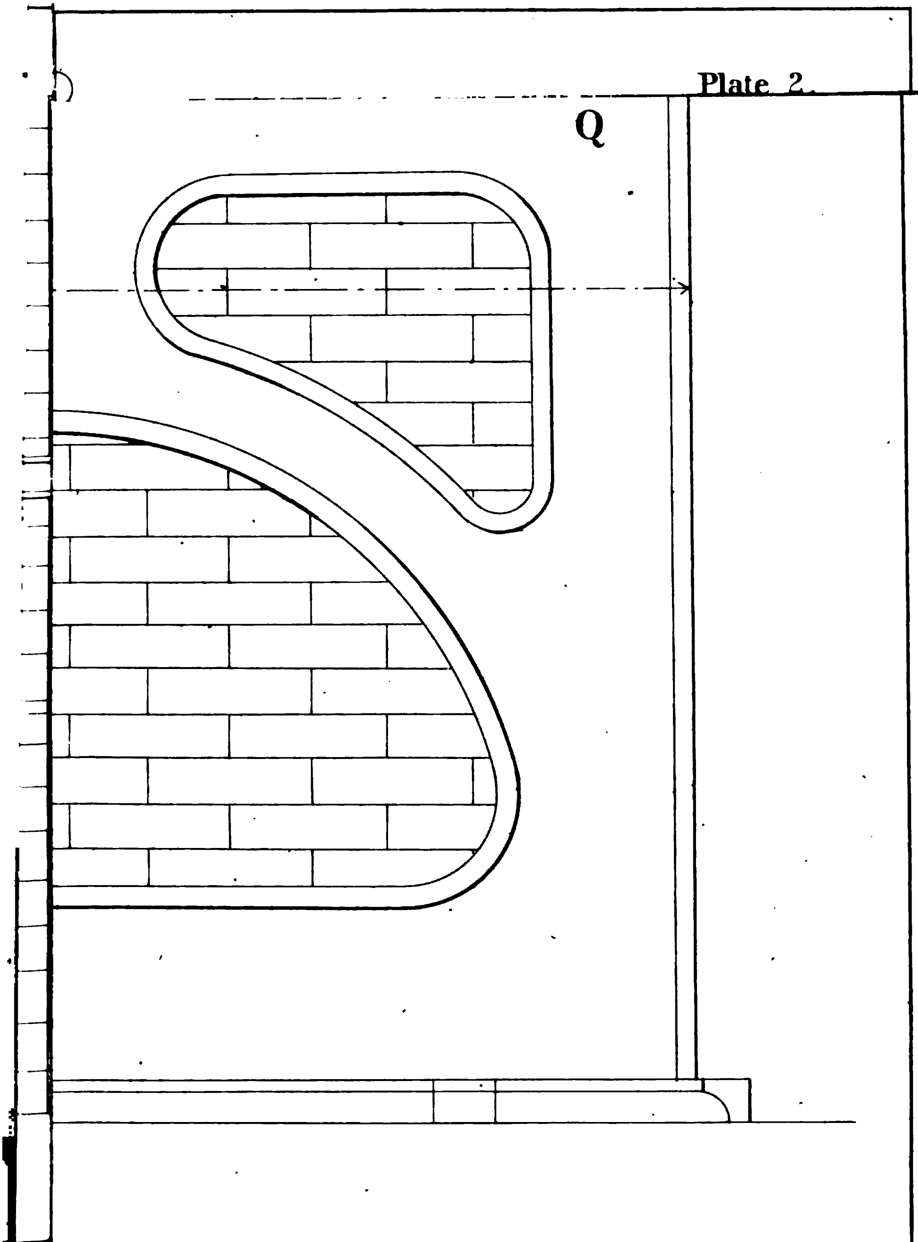
Fig. 10.

being hollow, and perforated with holes for promoting the admission of air in proper degree for the perfect combustion of the fuel.

To kindle a fire the doors, G G and B, are opened, and the operation conducted as in ordinary furnaces.

"Decomposition of fuel having commenced, combustible gases are set free, portions of which escaping unconsumed, smoke appears.

Plate 2.



Specially designed for Dr. Morfit's Work on Soaps.

"When the fire has been burning fifteen minutes to half-an-hour, close the ash-pit doors, and leave the ventilators, FF, and air passage door, B, open. The large quantity of air which has been passing through the grate bars being thus shut out, and the demand for it in the furnace increasing with the increased heat and rapidity of combustion, it now seeks other means of ingress, and consequently passes with increased vigour into the air flue B^1.

"The interior of the fire chamber soon becoming *highly* heated, imparts a portion of this heat to the central conical bars, I. The cold air passing into the air flue, B^1, and coming in contact with the bottom cross section, C, of the central bars, becomes in consequence evenly and moderately heated. Passing through these it impinges against the thin section, J, of central bars, which being hotter than the cross section, raises the temperature of the air still higher. Passing now along the sides of these it strikes the thicker portion of the bars, and these being seldom below a red heat, the air is made yet hotter.

"The air-distributing bars being placed in the central portion of the furnace, and extending its entire length, meets one of the conditions for perfect combustion, viz., that every part of the burning mass, whether solid or gaseous, should be brought into contact with pure air;—air uncontaminated with the products of combustion. By this arrangement there are the ignited carbon and combustible gases at the sides of the fire-chamber, and pure air in contact with these, while the hundreds of minute orifices between the bars permit the air to come into *intimate* contact with the fuel. When the combustible gases are set free and rise to the lowest series of perforations, the atoms of oxygen obtained from the currents of fresh air entering in minute streams, seize upon the atoms of the gases which are at a high temperature, and form so many points of flame.

"If all the volatile carbon and the gases are not consumed at the lowest series of orifices, they pass up to the next, and so on, so that no part of the fuel escapes perfect combustion. Another important condition for perfect combustion is here met, namely, that the supply of air should be regulated by the demand, no more air being supplied than can be absorbed by the gas with which it comes in contact. This provision is of great value, because an excess of air beyond what is absolutely required for chemical union, must have a cooling influence; but when all the air which passes through the perforations is required for combustion, heat is constantly developed.

"By admitting the air by jets, minute currents are created at those points where the temperature is the highest. These of course are the points where combustion has already commenced. The atoms of oxygen seize with extreme energy upon the atoms of combustible material, in accordance with the inexorable laws of chemical action, and the nitrogen and carbonic acid, together with water in the form of vapour, are carried off through the flue by the ascending current. In the use of coke, anthracite coal, or other carbonaceous fuels, the distribution of pure atmospheric air in a required quantity by the numerous jets, prevents the loss which would otherwise occur, by the escape of the fuel in the form of carbonic oxide.

"On filling the fire-chamber of this furnace nearly half full of shavings, saw-dust, or coal-dust, a fine exhibition of the complete combustion of volatile hydro-carbon ensues. These inflammable vapours are not perfectly colourless, but have a light cloudy appearance, closely resembling the gas which is conducted from the central cone of a candle. They may be seen playing among the particles of fuel, and when they come in contact with the jets of air, the interior of the fire-chamber is filled with hundreds of beautiful gas lights, thus enabling us to raise steam in an exceedingly short space of time. Where saw-dust, shavings, or any rubbish containing a considerable amount of hydro-carbons can be obtained, the use of coal may be almost, if not entirely, dispensed with."

2. A super-heater in connection with the boiler is absolutely necessary, as it not only economizes fuel, but time also, by bringing the oil rapidly to temperature with steam of much lower pressure than would be required without its use. It is constructed of very thick wrought-iron welded tubes, *v*, and should consist of several coils or lengths after the form and proportions shown by Plate I. Each length, *v*, is made of pieces with screw-joints, *s*, so that when any part may become burnt, it can be easily replaced without the trouble and expense of getting an entirely

new super-heater. It is only necessary to take down the side of the brick-work which encloses the super-heater. In the brick-work (front) above the fire-door is a small door, *d*, through which can be examined the heat-colour of the super-heater.

The internal diameter of the tube is 1½ to 2 inches, and as the steam passes from the boiler into the super-heater, as well as from the latter into the jacket of the soap-pans, its temperature should be noted by means of a pyrometer properly adjusted to the tubes.

Communication between the super-heater and soap-pans is made by means of the bronze cock, A; and B is another bronze cock, which opens communication between the super-heater and the steam-boiler, or generator. When A and B are closed, the bronze cock, C, serves to open direct communication between the generating boiler and the soap-pans.

In the batteries hitherto installed by me there were no pyrometers, because of the difficulty of obtaining such an instrument of suitable construction. Now, however, good ones are manufactured by W. J. Ledward, Middleton-on-Tees. That intended for gauging the high temperatures of superheated steam is known as Gauntlett's Patent Pyrometer. The tubes are of highly refractory clay, and its action is both sensitive and durable under any pressure of steam. It is made to register from 0 to 2000° Fahr., or to indicate an equivalent range according to the scales of Celsius and Reaumur as may be desired. The cost is *4l.* *4s.* for the instrument as described; but they are made also at the higher cost of *8l.* *10s.*, with a clockwork attachment, whereby the temperature is recorded on a sheet of paper by the pyrometer itself. The instrument, and its mode of application, are shown by Figs. 11 and 12.

3. A strong wrought-iron soap-pan, with

steam-jacket, stirrer, and framework, after the form and proportions shown by Plate II. The thickness of the iron plate should be

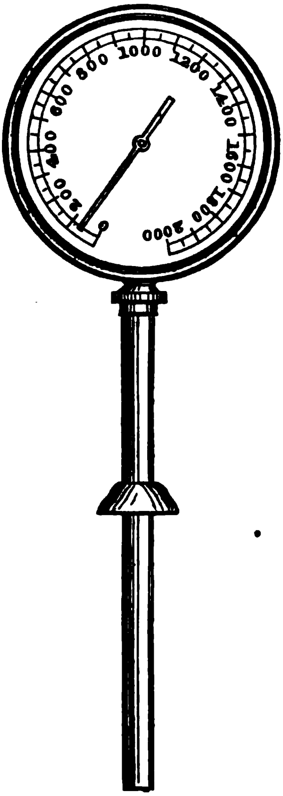


Fig. 11.

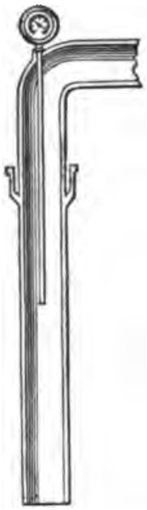


Fig. 12.

about five-eighths of an inch, in order to insure durability and prevent accidents, for the steam will be used at a pressure of 50 to

60 pounds. This pan serves for the boiling of the soap, and it should be placed as near as possible to the steam-boiler, but in an apartment separated from the boiler-room by means of a brick partition. This close proximity is indispensable when a super-heater is not provided, in order to prevent the cooling and condensation of the steam during its passage from the boiler to the pan; and then, also, the steam must be used at the high pressure of 75 to 80 pounds. The tube which feeds the pan with steam should have an interior diameter of at least 2 inches. The lower part of the pan must rest upon a strong foundation, and about 3 feet below the level of the floor of the apartment, in order to produce solidity, and facilitate the shovelling out of the finished soap into the cooling frames. The space between the sides of the pan and its cast-iron framework or support, Q, should be closed with earth and brick-work so as to economize heat. The discharge

tube, *o*, of the jacket should have its exit outside the building, or better, in the condensing reservoir, so as to prevent inconvenience from an atmosphere of steam, and save the distilled water for making the solutions of alkali. Above the soap-pan is a moveable curb, O, which can be fitted to its place, at will, by means of its india-rubber joint and press screws, *n*, *p*, drawn to a scale of one-fourth the natural size on Plate III. The object of this curb is to allow room for the intumescence and uprising which occurs in the first stage of the boiling operation. A wheel arrangement, *w*, at each side of its outer circumference, affords the facility of pushing it back, or drawing it forward, upon the railway fixed in the wall at the rear and the columns, N, of the cast-iron frame, when the finished soap is to be shovelled into the frames, or a new boiling is to be made.

The pillars, N, of the iron frame, support

Scale of Pans

Vincent Brooks Day & Son Lith

Specially designed for Dr Morfit's Work on Soaps

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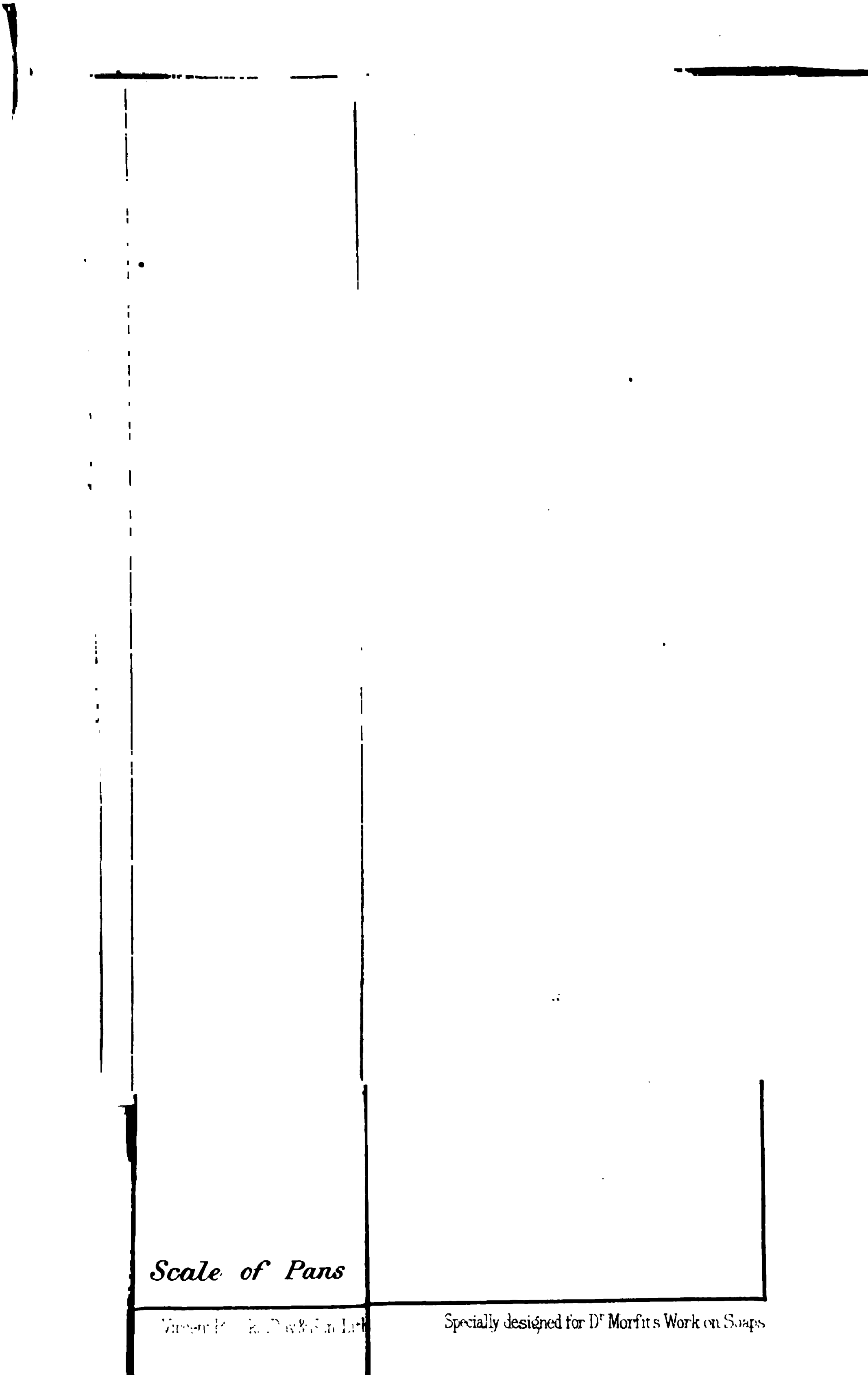

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the gearing, M, which moves the stirrer, R′, at the rate of forty revolutions per minute. A more rapid movement would impair the density of the soap. The stirrer, R′, is strongly made of forged iron, so as to resist the power of the paste towards the end of the boiling, when it becomes dry and stiff: and as the paste has then a tendency to move around in mass, it is necessary to make the stirrer with two wings, or sets of blades, moving in opposite directions, in order to produce a thorough action. In other words, the lower dasher, or wing of the stirrer, must move against the upper. In default of such a double stirrer, there must be toothed traverses, or cross-bars, strongly fastened to the sides of the pan, for breaking the paste as it is carried round in mass by a single wing. The blades or teeth of the stirrer should always be arranged vertically, if possible, as they produce a much handsomer paste than a horizontal stirrer.

The simpler arrangement of fixed traverses with teeth for breaking up the soap paste as it is driven round by a corresponding revolving dasher, economizes the cost of the pan and its accessories in an important degree, for the double revolving stirrer is a patent invention, and requires compound and expensive gearing to put it in motion. The latter, however, has some advantages in its favour, though not sufficient to counterbalance its greater cost. Plate III. shows the pan of simpler construction in the most approved form and proportions, and after my own design.

In all respects, except the stirrer and gearing, it is the counterpart of the pan shown by Plate II. The stirrer is a single one, and therefore requires a much simpler and less expensive gearing, M. Its arms are fitted with cross-teeth, *r*, so placed as to intersect the cross-teeth of the traverses, *n*, fixed across the diameter of the pan to the sides, and acting as breaks. All parts of the mass are thus reached during the revolution of the stirrer, and the stirring is, therefore, thorough. These traverses, as well as the arms of the stirrer, may be of cast-iron, provided care is observed to select it of good quality. In this drawing, the slot, *m*, which closes the opening in the curb, O, is shown with its binding-clamps, *t*, in place, as well as separately, and drawn to a scale of one-fourth the full size.

The pan has the capacity for working ten hundredweight of oleic acid at each operation; and four operations may be put through readily each day of twelve hours, thus giving a daily product of three tons of soap and upwards. The dimensions of the pan, and indeed of all the several pieces of apparatus, have been determined, by a long and costly experience, as the best with regard to economy of time, fuel, labour, and of maximum excellence of soap.

4. To obtain uniform results the proportions of raw materials must be weighed or measured exactly at each operation. For the measurement of the red oil it is necessary to have an iron vessel gauged to 1000 pounds and placed above and near the soap-pan so that its contents may be allowed to fall into the latter through a cock tube. This graduated vessel is to receive its charge from the large reservoir provided for storing the oil, and through a fine sieve of tinned wire cloth in order that any sticks or dirt may not enter the soap. A more convenient arrangement would be to affix to the large or storage reservoir one of Forrest's measuring tubes, shown by O, figure 13. This tube may be made of sufficient capacity to measure ten gallons each time, and the oil may be drawn from it into the soap-pan through a sieve as before directed, and the measuring repeated until the requisite charge is run into the soap-pan.

It should be remarked here that the storage reservoir must be supplied with a close iron tube hugging its interior sides near the bottom and debouching on the outside into a drain, for the passage of a current of steam when it may be necessary, in cool weather, to increase the fluidity of the oil for straining. Here, too, the measures should be taken as near 62° Fahr. as possible, but sometimes there are oleins which remain

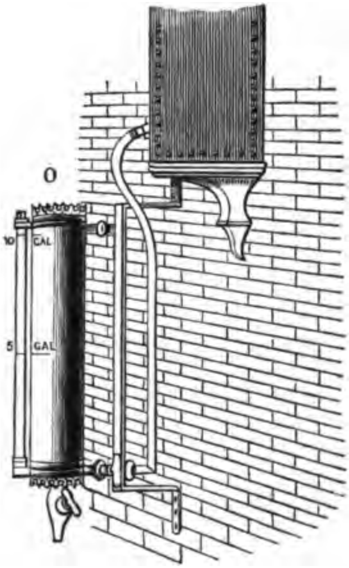


Fig. 13.

thick up to 75° and even 80° Fahr. In these latter cases rather scant measure must be taken to compensate for the contracted state of the olein.

As the barrels or hogsheads of oleic fat reach the factory, they should be rolled into a store-room kept always at 70° to 80° Fahr. In winter this warmth may be readily and economically maintained by means of an iron tube running around the wall just above the floor, and connecting with the steam boiler of the factory. A stop-cock attached will allow the steam to be let on or shut off as may be required.

The oleic fat being thus kept fluid can be readily pumped at will into the reservoir, placed above or below according to the arrangement of the factory. The "American Rotary Pump," shown by figure 14, which will lift 25 feet and force to any distance, is a most serviceable implement for mounting the oil from the barrels into the storage reservoir.

It costs, with barrel attachment, about 4*l.* or less.

5. A wooden platform, H, Plates 8 and 9,

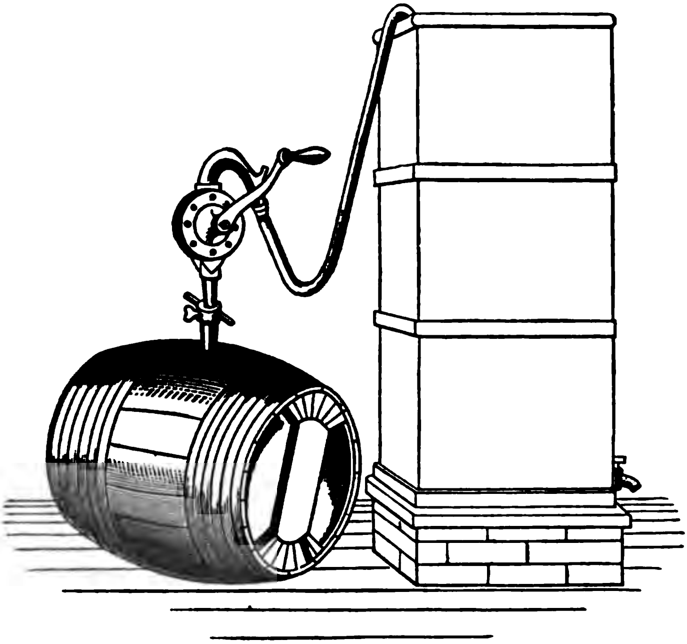


Fig. 14.

supported by pillars or posts of twelve feet height from the floor, is placed above the soap-pan for the arrangement of the alkali vessels.

6. The soda-pan or feeder is cylindrical, as

shown by figure 15. It is made of wrought-iron plate lined or coated with lead on the inside. It should be fitted inside with a gauge-rod, so as to facilitate the proportioning of soda solution according to the several kinds of soap to be made. The liquors should be measured always at 62° F., as nearly as possible, that degree being the ordinary temperature of the atmosphere of the interior of the manufactory. If this precaution is not regularly observed the expansion of the liquids, varying with the temperature, will cause inequality of weights.

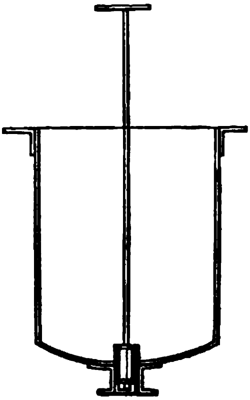


Fig. 15.

The feeding-pan is firmly fixed in place by means of a circular support, and has its exit tube and cock passing through and below the floor of the platform. The cock must have a large passage-way or bore, in order that it may not become stopped or fixed by the crystallization of the soda salt. To more perfectly protect against such an annoyance, the cock and tube must be thoroughly washed out with a jet of steam after each operation. The opening in the bottom of the feeder, to which the exit tube is adjusted, must be furnished with a movable tampon, *a*, figure 16, of india-rubber with iron handle, *b*, so that it may be closed or opened at discretion. The tampon must always be in its place when the feeder is charged with solution; otherwise the liquor will run down into the tube before the proper time, and, by cooling and crystallizing around the cock, cause the latter to

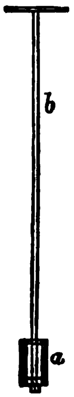


Fig. 16.

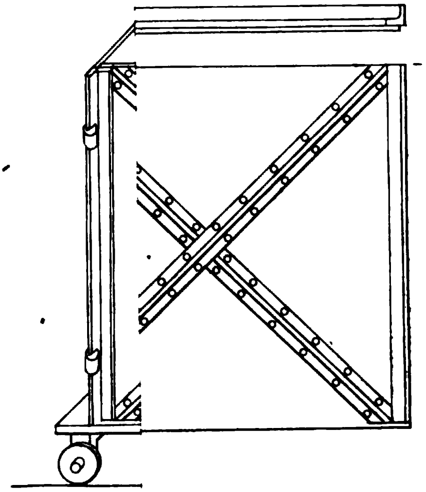
"stick." The internal diameter of the exit tube should be one and seven-eighths to two inches.

This feeding-pan is heated by a current of steam descending from the top, through a lead-coated iron tube of about a half-inch internal diameter, and flowing out at the bottom. The more convenient dimensions for a feeder or alkali pan are 38 inches internal depth by 30 inches internal diameter, and there should be one for each soap-pan.

Refined Jarrow ash of 52°, the soda material employed in this system, being very white, soluble, and free from sand or silex, its use dispenses with the necessity of a reservoir for storing a ready supply of alkaline solution, as the requisite portion for each boiling of soap can be dissolved in the feeder as wanted. This saves considerable expense in equipping a factory. The water must be always brought to boiling before commencing to add the ash, else the latter will form lumps

Plate 4.

SIDE.



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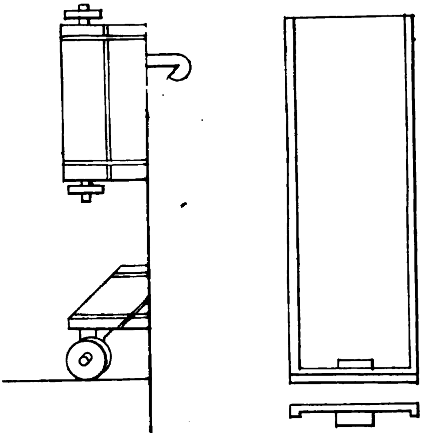

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and cause delay in the solution. So also the better to insure against this latter annoyance, the ash should be sifted in through a coarse sieve, during constant stirring of the liquor. At the mouth of the tube, running from the feeder, there should be a sieve-arrangement so as to intercept any possible dirt or solid particles as the liquor runs into the hot oil.

To save the trouble of weighing the Jarrow ash for each and every batch of soap, strong iron-edged boxes of oak, holding the required weight, should be provided as measures for carrying it to the solution-pan. This ash, being generally of uniform composition and specific gravity, rarely presents any variation of the relation of weight to volume. When bought of 52° strength and wholly carbonated, there is no margin for an extra proportion of foreign matters.

7. A pan, figure 17, similar in form to the feeder, but of only twenty or thirty gallons

capacity, say twenty-one inches wide, and thirty-six inches deep internally, is to have a place adjoining the soda-feeder, this vessel being for the purpose of containing and heating the water which gives to the paste its final treatment or washing. Its exit tube is fitted at the end with a *pomme d'arrosoir* or perforated spout, so as to spread the water as it falls into the paste. The given proportion of water being put into the pan and brought to 212° F., by means of the current of steam entering through a lead-coated tube, is then ready for use. This water-pan is to be constructed of iron plate coated with zinc, and known as galvanised iron plate.

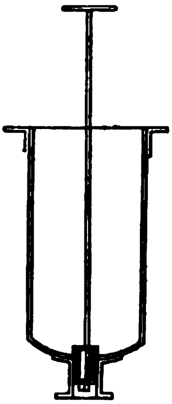


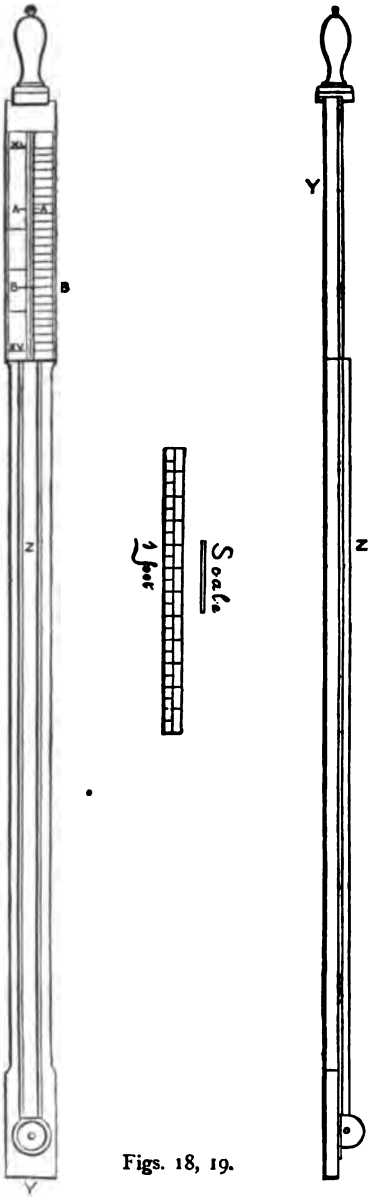
Fig. 17.

8. An iron-plate reservoir of two thousand gallons is necessary for storing the condensed water to be used in making the solutions of

alkali and in washing the paste. This reservoir should have a scale graduated to gallons, and be supplied also with a strong and large cock. If possible, distilled water should be used for making the solutions of alkali, more particularly when that from the well or hydrant is hard; for then the waste of soda is prevented. The exhaust steam from the engine and pan jackets should be condensed for this purpose.

9. Two thermometers, figures 18, 19, of about four feet in length, are to be suspended by cord and pulley over the soap-pans. They should be set deeply in round wooden stems or supports, and have ·porcelain or slate scales at their upper parts. Each scale is to have only six graduations expressed by the ciphers, as will be described below.

Over the length of the glass tube is an arched slip of wood as a cover protection against breakage, shown by z.



Figs. 18, 19.

The interval of the scale is divided into spaces and subspaces representing 20 and 4 degrees respectively. It commences at 250° Fahr. = xv.

The highest degree to which the oil need be heated is indicated by A A = 320°. The other extra line below B B is placed at 282° Fahr., or the minimum.

This mystery of ciphers is designed to conceal the actual temperatures employed, from the workmen and outsiders, in taking the temperature of the oil when it is about to be converted into soap.

10. A gauge rod of wood for the feeders, graduated to gallons after the form of that in the alkali feeder, is required for measuring the necessary proportions of wash water.

11. Sixty iron frames are necessary for the cooling of a daily product of two tons of soap. To prevent the coloration of the exterior of the soap by iron rust, the frames must be made of galvanized iron, or else lined with a thick cotton duck previously well shrunk. The form and proportions of these frames are shown by Plate 4, each frame having a capacity of about 400 pounds of soap. The side pieces are wrought-iron plates, and the ends and bottoms are of cast-iron. They move on wheels, and can be put together and taken apart at will, the movable clamp irons, *a*, serving to hold the several parts in place. To insure durability and

freedom from accidental breakage, the axles must be of wrought-iron.

12. Two shovels of strong steel plate are required for transferring the finished paste from the pan into the frames. They should be rounded at the end corners and have handles of five feet length. These handles must be strongly set to the shovel in order to prevent breakage in reaching the further side of the pan.

13. Two cutting-machines, one for bars and the other for blocks. The cheapest and most efficient form is that used in England, and shown by Plates 5 and 6. The framework is of wood and the mountings of wrought-iron. As much annoyance is occasioned by the frequent breaking of the cutting wires, I have made an improvement which remedies that defect in the most satisfactory manner. This consists in the substitution of thin steel knives, *k*, for the usual wires, which are not sufficiently

strong for cutting the hard soap of this system.

14. Soap for manufacturers' use need only be cut into bars; but, for the general market, it is expedient to supply tablets of a pound or less, and in order to give them a distinct imprint of the trade mark, and otherwise impart a handsome appearance, they should be pressed. A very serviceable machine for doing this work rapidly is made by A. Noel, No. 98, Rue Rébeval, à Belleville, Paris. After some little experience in working it, one man can press 7,000 to 8,000 blocks per day of twelve hours. This press and its accessories are shown by Plate 7. It costs 16*l.*, and with engraved mould box 8*l.* additional. Soaps pressed in this manner are not only more convenient for use, but pack better for exportation, as there are fewer points of contact to cause sweating or softening of the outer surfaces of the blocks in the hot atmosphere of the ship's hold.

Two pans, and their accessories, as described, constitute a battery; but, for a moderate scale, one pan, and half the prescribed number of cooling frames, will form a sufficient plant. It is more economical, however, as to rent, office expenses, fuel, and labour, to work two pans at a time, if the demand for soap will justify that course.

Another point of economy is to have the pipe-connections of the jacket pans of thick and strong copper, for, though more costly at first, they are cheaper in the end than those of iron. They keep in good order, and save loss of time by reason of leaks and necessary repairs. The tubes for conveying the alkali from the feeders to the soap-pan should be of copper coated with lead.

CHAPTER V.

THE ARRANGEMENT AND COST OF A FACTORY PLANT.

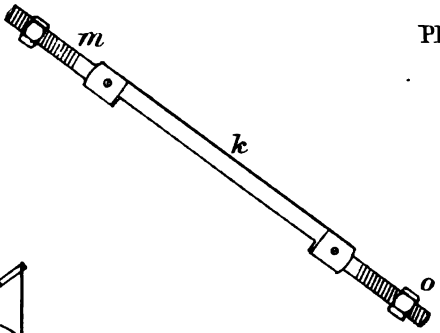
THE factory established in London according to my plans, is to be considered a model one, as all its appointments are the result of a tedious course of experiment on a practical scale. Its cost, therefore, is much more than would be that of a new plant constructed from the approved designs now shown in Plates 8, 9, and 10. These represent the apparatus in place just as it has been worked, all the measurements being to a scale. On the score of economy as well as convenience, it is expedient to have two pans, so that while one is being emptied, the other may be put into operation. The factory should have some yard and shed room for storing the empties.

SIDE ELEVATION OF THE ANNEX CONTAINING THE MACHINERY.

Plate 8.

A, *A*, *A*.	Walls and roof of building.
B, *B*.	Floors of ditto.
C.	Chimney shaft.
D.	Brick piers for supporting the soap-pans.
E, *E*.	Two lead-lined circular feeders, for alkali.
F.	Galvanised-iron feed-pan or washer, for water.
H, *H*.	Supports and casing of wood for *E*, *E*, and *F*.
I.	Main steam-pipe to the feeders.
J.	Water supply to ditto.
K.	Shafting and rigging for driving stirrer gear.
L.	Leaded-copper supply-pipes from feeders.
M, *M*.	Stirrer gear.
N, *N*.	Iron columns to support *M*, *M*.
O, *O*.	Movable curbs (with movable fronts) running on railway.
P, *P*.	Iron-lever arrangement, for raising and lowering *O*, *O*.
Q, *Q*.	Standard frames of iron for soap-pans.
R, *R*.	Pans, with stirrer inside, for a charge, each 1,100 lbs. oil.
S, *S*.	Manholes in brickwork.
T.	Super-heater.
U.	Pipe regulated by cocks and leading to pans *R*, *R*, for supply of either raw or super-heated steam.

Plate 5.



KNIFE — SCALE OF 1/4

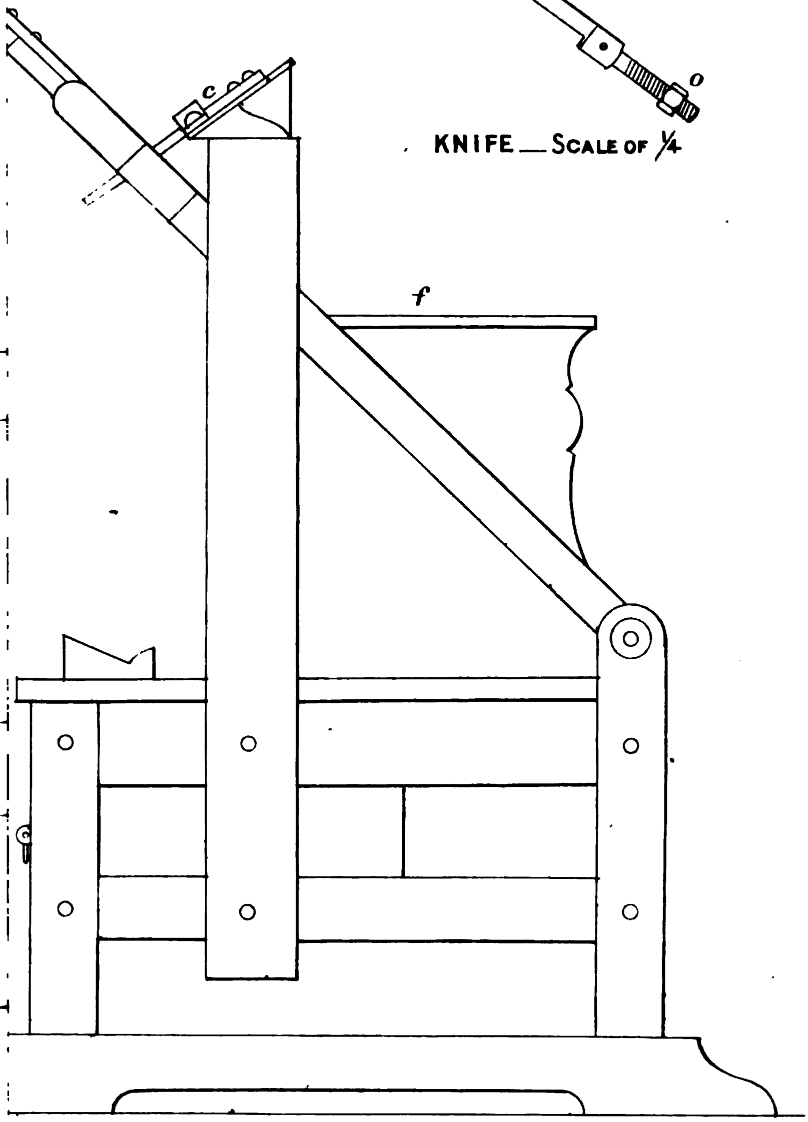


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Plate 8.

V.	Steam-engine.
W.	Forge, vice, anvil, and tools.
X.	Water cistern.
Y.	Oil reservoir, with pump for charging the measure *Z.*
Z.	Iron cylinder for measuring oil.
a, a.	Blow-off pipe.
b, b.	Water supply to pump.
c.	Driving band from engine to the gear above.
d, d.	Movable gutter for leading oil from measure to pans.
e, e.	Steam pipe, passing through the oil reservoir *Y,* to keep fluid the contained oil, so that its contents of solid matter may be uniform throughout.
y.	Tampon.

END ELEVATION.

Plate 9.

A, A.	Brick walls of building.
B, B.	Floors of room and balcony platform above.
D^1.	Brickwork of steam boiler.
D.	Brickwork of pier-support for soap-pans.
H.	Wood support or stand for *E.*
G.	Thermometer, gallows, and pulleys.
K.	Driving pulleys for stirrers.
O, O.	Movable curbs, as shown by dotted lines.
Q.	Iron framework, for supporting soap-pans.
R.	Soap-pans with stirrers inside.
V^1.	Steam-boiler.
V.	Steam-engine.
c^1.	Driving rigger.
c^2.	Overhead gear, with pulleys, &c.

Plate 9.

c.	Driving belts.
O.	Iron railway on which the curbs are moved back and forwards.
P.	Iron lever arrangement for raising and lowering curbs.
G^1.	Thermometer suspended on pulleys from a gallows.
V^2.	Steam-pipe to engine.
V^3.	Exhaust-pipe from engine.
V^4.	Pit for flywheel of engine.

GROUND PLAN.

Plate 10.

A, A.	Brick walls of building.
B, B.	Floors of room and balcony platform above.
D, D.	Brickwork of pier for the soap-pans.
V^1.	Steam boiler; V^5, safety valve; V^6, steam chest.
R, R.	Soap-pans and cast-iron supports or framework.
U.	Steam-pipe to super-heater.
U^1.	Steam-pipe to soap-pans.
V^2.	Main steam-pipe to engine.
b′, b′.	Water supply from engine pump to boiler.
b, b.	Water supply from cistern to engine pump.
X.	Water-cistern.
V.	Engine.
V^3.	Exhaust-pipe.
C.	Chimney-shaft.
C^1.	Flue.
T.	Super-heater.
Y.	Oil reservoir.

The following is a fair estimate of the total cost of a factory equipment, of the best materials and workmanship, after the plans and descriptions already given:—

One steam-boiler (25-horse power)	£200	0	0
One steam-engine (8-horse power)	100	0	0
One super-heater	20	0	0
One water tank (2000 gallons)	32	0	0
One oil tank (2000 gallons)	32	0	0
One oil measure and pump	12	0	0
One platform balance	20	0	0
Two soap-pans, frames and gearing (8 to 9 tons)	300	0	0
Two alkali feeders (lead-lined)	20	0	0
One water feeder (galvanised iron)	5	0	0
Shafting and pulleys	25	0	0
Sixty cooling-frames (galvanised iron)	325	0	0
One cutting-machine, large	15	0	0
,, ,, small	10	0	0
Two thermometers	4	0	0
Four iron boxes on wheels (galvanised iron)	25	0	0
Press and dies	50	0	0
Fittings in metal	50	0	0
Copper, iron, and lead tubing	30	0	0
Bronze cocks	20	0	0
Machine work	35	0	0
Carpenters' work and materials	50	0	0
Masons' work	50	0	0
Incidentals	100	0	0
Superintendence	200	0	0
Total cost of plant	£1730	0	0

Lifting Pulley.

It will be proper here to mention an economical, convenient, and powerful apparatus for lifting the several parts of the heavy machinery into place, called "the differential-pulley blocks." As made and sold in England, it is shown by fig. 20; and one by which a man can lift two tons will cost, with spocket wheel and the requisite quantity of chain, 4*l*. When worked from below by pulling the chain, the length of the latter must be four times the height of the lift. The shears are of unequal diameters, and there are two snatch blocks. As the load ascends,. the empty hook descends, thus

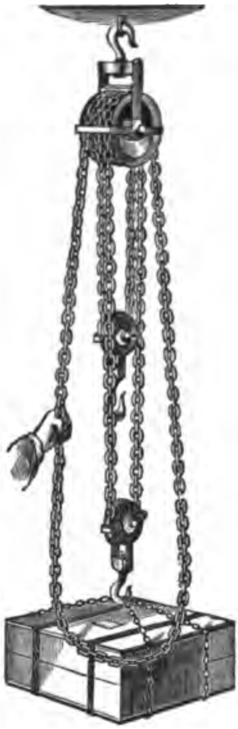


Fig. 20.

forming a double lift, and obviating the necessity of pulling the chain down for a fresh load. The load will remain suspended at any height, even when the hand may be suddenly taken from the chain.

To raise or lower light weights quickly, a noose must be formed in the hand chain, or a hook attached to it.

This apparatus is quite portable; but, before moving it from place to place, it is necessary to tie the four chains tightly round and close to the upper block, and the two chains, also, close to the lower block, in order to prevent any twisting. It is also necessary to remember that the pulleys will not work freely when the chains are twisted, and these must be kept, therefore, in proper adjustment.

Lubricator.

Another aid to the operations of the factory, on the score of convenience and economy, should also be noted here. It is a very simple implement, acting automatically, for keeping the bearings of the shafting well greased. This lubricator is shown by fig. 21, about half of the full size, and it costs about a shilling. It is known as Lieuvain's needle lubricator, and is constructed upon a pneumatic, self-acting principle. The bottle, or portion A, which contains the oil, is of glass, fitted at its neck with a wooden stopper B, through which passes a conical metal tube C, forming the only exit for the oil. D is a moderator-tube. In order to regulate the supply of oil, a metal rod or needle E passes through the tube. The stopper is made of wood in order to accommodate the contraction and expansion of the neck of the bottle by heat or cold, and thus prevent breakage.

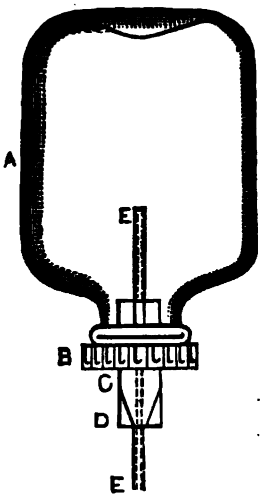


Fig. 21.

The apparatus is filled with oil and turned neck downwards, and the lower end of the stopper is fitted over the bearing of the shaft; the needle (E) alone descends, and comes into contact with the parts requiring to be lubricated, the least movement of which produces an oscillation or vibration of the needle which disengages a small portion of oil and causes it to descend from the globe, the quantity being in proportion to the speed. When the machinery stops, or is not in motion, no oscillation of the needle takes place; and the pressure of air at the base of the tube, as well as the partial vacuum formed in the globe, prevent the oil from descending until the machinery is again set in motion.

Its economy in saving of oil is incredible; an ordinary bottle, containing but a small quantity, will lubricate a small shaft turning 150 to 200 revolutions per minute, for upwards of a month.

Should the oil descend too freely, in consequence of the lubricator being fixed in a high temperature, or other cause, the needle rod should be replaced by a thicker one; or, on the contrary, if insufficiently, the rod should be slightly filed on one side, or a thinner one substituted. These alterations, however, are rarely necessary.

CHAPTER VI.

THE PROCESS.

As has been already remarked, red oil is a fat acid, and "sal soda" is a salt which contains a large quantity of water of crystallization. Consequently, when these two materials come together in the pan, under conditions which promote the heating and mixing of them simultaneously, decomposition of the salt takes place. The carbonic acid escapes as gas, being driven off by the more powerful fat-acid; and in its haste to get away produces a great boursoufflement or uprising to near the top of the curb. At the same moment the fat-acid unites with the soda, thus rendered caustic by being set free from its carbonic acid; and these two elements in combination carry along with them the isolated water of crystallization of the soda salt to form soap. The soap, being thus composed in a manner strictly chemical and scientific, possesses very superior properties not easily imitated by any other method. The water of crystallization of the soda salt becomes, by this means, the water of constitution of the soap, and, entering therein at the moment of elimination, fixes itself permanently as a definite part of its composition, and not as a mere mixture ingredient.

The following diagram will explain the changes which take place in the soap-pan.

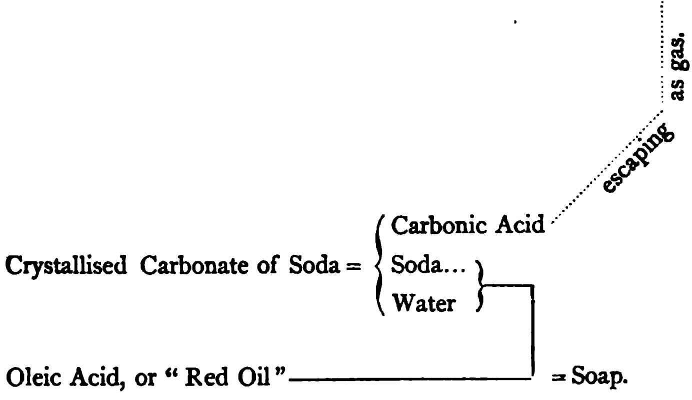
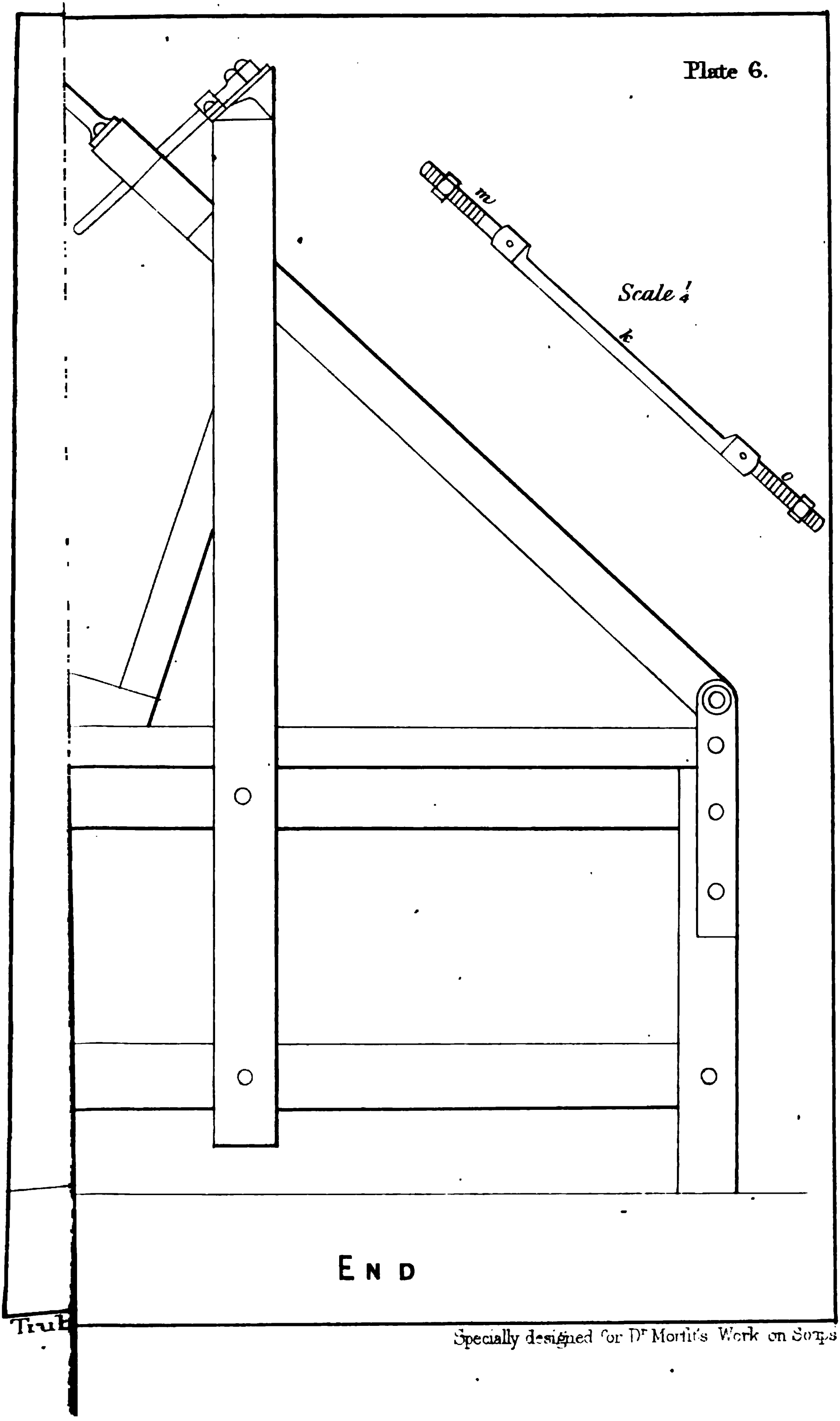


Plate 6.



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In making soaps with neutral fats, it is necessary to use *caustic* lyes in order to break up the natural combination of the fat-acids with their glycerin base. This requires many changes of lye, repeated and prolonged boilings, as also much experience. Moreover the process is uncertain, time-consuming, and expensive. All these disadvantageous circumstances are avoided by the use of this system. The soap is made in one simple operation, so that four boilings, at least, may be completed daily in each pan; whereas two weeks are required for only one boiling by many of the usual processes.

The first step is to heat the soap-pan thoroughly by means of a current of steam let into its jacket, the steam-boiler being under a pressure, at the time, of four atmospheres. The charge of red oil or fat acid, say 1000 pounds, is then to be run into the pan through a sieve, and the heat of the steam raised by super-heating. The usual custom, in the absence of a super-heater, is to raise the steam in the boiler to a pressure of five to five and a half atmospheres; but this latter degree should be the extreme. When the intervention of a super-heater is employed, its tubes must be kept at a violet or bright violet redness. Care should be observed also to stir well for three to five minutes after drawing up the thermometer, and just previous to adding the alkali-liquor, in all those cases where solid fat or rosin mixture forms part of the fat stock; otherwise the resulting soap paste will not be homogeneous or handsome.

During the heating of the oil, the curb O is to be adjusted to the pan R (Plates 2 and 3) by means of its screws, *p*, and india-rubber washer, *n*, and the slit-gate, *m*, of the curb arranged tightly in place—a work which consumes only a few minutes. The thermometer, fig. 18, is then to be lowered into the oil, and the degree of heat observed from time to time. When the oil has reached A A (320° Fahr.), the thermometer is to be drawn up. Two minutes afterwards the oil will be hot enough to receive the alkali. In heating the oil, care should be observed not to exceed in any instance the 320°; nor yet to have it cooler than B B, or 280° Fahr.

In the meantime the solution of alkali must have been made quite ready for entering the oil at this moment. This is done by charging the feeder, fig. 15, with the necessary quantity of water, raising it to 212° Fahr. by a current of steam, and then sifting in the equivalent proportion of Jarrow ash during continuous heating and stirring until all the ash is dissolved. The addition of the ash must be gradual to prevent "lumping" and delay. The liquor itself must be at 212° Fahr. when let into the heated oil.

If a neutral soap is required, then the proper quantity of Jarrow (52°) carbonated ash will be 190 pounds per 1000 pounds of oleic acid. For a strong soap the proportion must be increased to 210—225 pounds. In each and every case, and to promote facile solution of the ash, two pounds of water must be taken for the solution of every pound of ash, or say one imperial gallon for every five pounds. This is rather more than the equivalent necessary for the formation of crystallized "sal soda," but the slight excess will pass off during the cooking of the soap. The solution of ash should have 212° Fahr. at the moment it is allowed to enter the oil; and at the mouth of the exit pipe there must be a bucket-sieve of galvanized iron and galvanized wire cloth to intercept the passage of any coarse particles or dirt. All being ready, the cock of the feeder is then to be opened, and the flow allowed to commence under such regulation that the whole shall not be less than six nor more than twelve minutes entering the oil in the soap-pan beneath. The stirrer is to be set in motion a minute or less after the flow of the alkali-liquor commences, and continued with the heating, uninterruptedly, during the cooking of the soap.

The chemical action being very prompt and very brisk, there is consequently much intumescence of the mass at first, and sometimes even a tendency to overrun the curb. This boursoufflement or uprising is due to the escaping carbonic acid of the alkali which, in assuming the form of gas, renders latent, at the same time, a great amount of heat. For this latter reason it is necessary to keep the current of steam at a temperature of four to five atmospheres (280°—310° Fahr.) during all the time of finishing the soap. As soon as the cream spongy mass produced by the boursoufflement has fallen to the bottom of the pan, it is time to loosen the curb, and push it back off the pan.

The subsidence of the mass occurs about five minutes after the addition of the last portion of the alkali. During the fifteen subsequent minutes, the mass changes from its spongy state into that of a clear, soft, homogeneous paste which soon assumes a brilliant appearance. Later it becomes more consistent; and in one hour and fifteen to thirty minutes from the moment that the alkali commenced to fall into the oil, the paste is so stiff and dry that it "cuts" or peels from the walls of the pan and the blades of the stirrer. A sample taken out at this moment upon a spatula quickly hardens at the surface, but gives a glazed streak when the finger is drawn across it.

At this stage of the operation, the paste should receive a wash of eight or ten gallons of boiling water from the feeder, fig. 17, above. To equalize the distribution of the water throughout the mass, it should fall through a cullender-spout at the end of the exit tube of the feeder. As the stirring and heating proceed, the paste becomes, at first, quite soft, but at the end of fifteen to twenty minutes it has regained its previous stiffness. This washing is necessary to give the soap its maximum excellence, and to diminish very materially any tendency it might have, otherwise, and in cold weather, to effloresce on the surface.

Previous to adding the wash water, the curb is unfastened by removing the screw clamps, and then pushed back on the railway from off the pan, so that time may be saved in preparing the latter to be emptied of its contents at the proper moment. The soap thus made is ready to be shovelled from the pan into the cooling-frames, Plate 4, an operation which requires the labour of two men for twenty minutes.

The soap represents the system in its integrity, and contains in the hundred parts—

Oleic Acid	65·00
Soda	6·7 to 7·50
Water	27·50

The soda in this soap bears the ratio of ten to eleven and a half of *caustic* soda to one hundred of oleic acid, by weight. If more than the normal quantity of water is required in the soap, it can be added after the washing, it being only necessary to stop the heating and stirring at the moment that the paste has acquired sufficient stiffness without having lost too much of the superadded water, by evaporation.

So, also, if it is required to diminish the cost of the soap by the use of an adulterating material, such as pipe-clay, sulphate of barytes, or dried sulphate of soda, it is to be sifted into the paste after the washing, and during constant stirring.

The better way, as to the sulphate of soda, however, would be to apply it in fluid form, for which purpose 100 to 150 pounds of the dry sulphate of soda are put into the wash-feeder with 30 gallons of water, and brought to solution by boiling. The heating and stirring of the paste must be continued while the liquor is running into it, and until sufficient stiffness has been assumed.

In the cases of pipeclay or sulphate of barytes additions, the heating is to be stopped, but the stirring must be continued uninterruptedly so as to produce a thorough mixture.

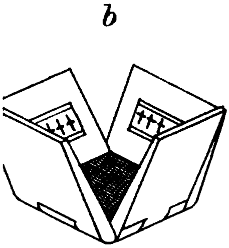
The addition of sulphate of soda improves both the colour and hardness of the soap in material degree, without seeming to injure its washing qualities, or degrade it otherwise than in composition. Consequently from five to ten per cent. may even be mixed with the soda ash in the manufacture, provided the soap is not to be used for the purposes of the dyer, calico-printer, and manufacturer of woollens.

As soon as one batch of finished soap is shovelled out of the pan, the oil for the next operation must be poured in, so as to make the boilings quickly successive, and thus economize time.

In order to secure uniformity of results, it is indispensable to observe, as strictly as possible, an uniformity in the weights and measures of the materials, the degrees of temperature, and the duration of the different stages of the manufacturing process. In this way, the soap will be always complete after a model, even though, as sometimes happens, in the case of certain brands of oleic acid, it may appear soft at the expiration of the regular time for the boiling. In such instances the paste may be more conveniently ladled out of the pan into the frames.

The paste is generally very firm in the frames on the day following, and it is hard enough to be stripped and cut into bars and blocks on the second day. In order that the blocks may have a handsome smooth appearance and a distinct imprint, they should be exposed for some hours before being pressed.

Plate 7.



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This exposure dries and hardens the surface. So, also, exposure after the pressing bleaches the surfaces.

One batch of soap, that is, the quantity made in one pan at a single operation, is called a cuite.

Three to four pounds of rosin per 100 pounds of oil, give a beautiful smooth appearance to the paste, and effectually prevent efflorescence in all soaps which contain less than 11·50 caustic soda to the 100 of oil. To prevent its giving a dark colour to the soap, it must be added to the oil during the heating of the latter and when it has reached 200° Fahr. The mixture of oil and rosin must then be further heated to 310° Fahr., and stirred for three minutes, just previous to letting in the alkali. The first quality of white rosin must be used. Its actual presence is not appreciable in the soap, to the eye at least, and it makes a wonderful improvement in the smoothness of the paste and quality of the soap; always provided, however, that the oleic acid is not thin.

In many respects, however, it will be more advantageous to add rosin soap, as made according to the instructions given in Chapter VIII., when the fat soap is finished, rather than rosin itself at the commencement of the operation. In such cases, the amount of rosin soap may be five per cent., or about 80 to 100 pounds per cuite of fat soap.

When the soap is made simply of a single fat and alkali and water, without any other admixture, it is termed *normal soap* as to its constituent fat; it being understood, however, that the quantity of ash employed in making the "normal soap" shall not much, if at all, exceed the equivalent proportion of 19 pounds per 100 of oil.

The machines for cutting soap have been described at page 106, but it remains to explain the mode of working them. When the soap is sufficiently hard, it is to be stripped by the removal of the sides and ends of the frames, for which purpose it is only necessary to loosen and remove the binding clamps with a hammer. If the frames have been made of iron coated with zinc, or "galvanized," then the block of soap strips easily and with a smooth skin. On the top, however, there is a hollow owing to the contraction of the mass during cooling. This uneven surface must be levelled by cutting it down to a smooth plane. To gauge a straight line as a guide for the cut, the rod,

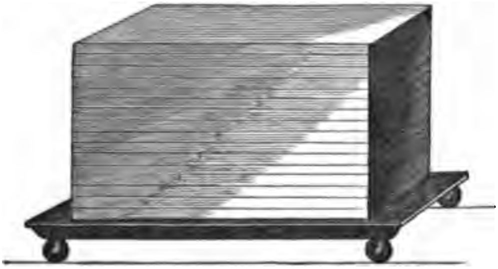


Fig. 22.

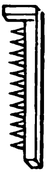


Fig. 23.

Fig. 23, is used. It is nothing more than a rod of wood with bevelled teeth like projections of steel on one of its surfaces. It should be as long as the frame is deep, and being placed with the lower end upon the base of the frame, is drawn along the sides and ends of the block of soap, as shown in Fig. 22.

The teeth trace the lines which the cutter is next to follow, not only for levelling the surface of the block, but for further dividing the latter into slabs. The manipulation for slabbing is very simple, and may be done with a malleable iron wire or a slabbing gauge box. The wire is shown with its two wooden handles by Fig. 24; and with the bend arranged around one end of the block must be drawn forward at the other end in the line scribed by the gauge rod, so as to

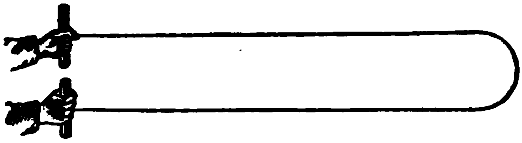


Fig. 24.

make an even cut. Each slab is to be set aside as soon as cut.

The first or upper uneven slab having been removed by means of the wire, then, for the further cutting down of the block, it will be better to use a slabbing-machine in place of the wire. This is a very simple implement, Plate 11, which can be set, readily, to any gauge, and does its work both smoothly and rapidly. It consists of a beech or cherry-wood frame-work, A, with long iron handles, B, in front. These handles are hung in hooks, *c*, so that their position may be under the control of the workman. Running across the box is a malleable iron wire, *d*, passing to the exterior of the sides of the wooden frame, through holes or slits, and winding round screw-key rods of iron, *g*, which serve to tighten and keep it in place. One long slit is preferable to a series of holes, because it can be made zig-zag, with the angles at distances apart to correspond with the thickness to be given to the slabs. By this arrangement, the wire may be shifted from gauge to gauge much more readily than through holes. To provide against wear and tear, the slit portion of the gauge should be faced both on the inside and outside with brass plates.

The slabber being set to the required gauge, the workman then places its forepart upon the rear end of the block of soap previously levelled by the removal of the uneven top with the wire, Fig. 24, and draws it forwards, from the opposite end, by means of the handle rods, B, a boy assistant, at the same time, pressing lightly upon the boards to keep the slabber in straight line. The wire is thus made to cut a neat slab of uniform thickness, which being removed, leaves the block ready again for a succeeding operation in the same manner as before. As the wire becomes loose by use, it must be tightened by means of the screw-keys, in order to preserve the uniformity of the slabs.

The irregular top-slabs, together with all subsequent scraps from the cutting operations, are to be put into a wooden vat, provided for the purpose, and mounted on a truck so that it may be moved about conveniently from

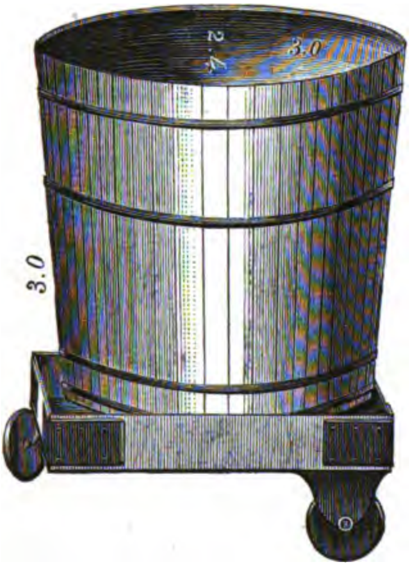


Fig. 25.

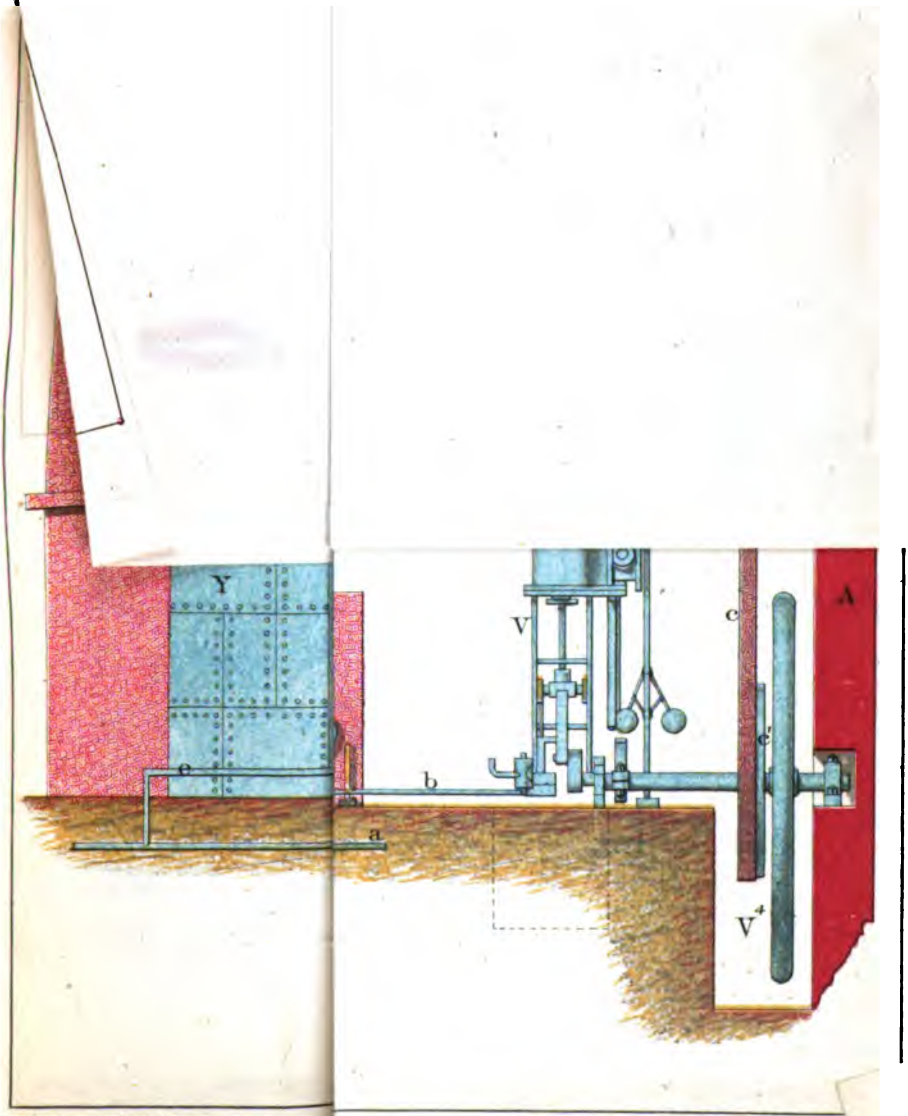
place to place. Fig. 25 shows this piece of apparatus made of wood in the form of an iron-bound oval tub; but galvanised iron would be also a suitable material for its construction.

The slabs are next to be divided into bars by means of the machine, Plate 5. The size of these bars depends upon the market for which they are intended, or the form and weight of the tablets into which they are to be subdivided for the press. The thickness of the slab must be regulated, therefore, first in relation to these circumstances, by shifting the wire as may be necessary. When the slabs are further to be cut into bars and tablets, then the number of knives and their intervening spaces must be adjusted, properly in advance, according to the sizes required. In England the bars have 14 to 14½ inches length by 2½ inches width, and 2½ inches thickness. The length, however, is not important, and may be several inches less. The tablets or lumps for household purposes are generally of a half or a full pound weight, and a mould box, *a*, *b*, Plate 7, for each size should be provided for the press.

The cutter is worked by means of the lever-frame, L, Plate 5, which contains the cutting knives, *k*, arranged by means of screws and nuts, *m*, *o*, so that they can be moved at will. In other factories, wires are used instead of knives, but the frequent breaking of them causes much inconvenience and loss of time. Indeed, the soaps made by this system are too hard to be cut rapidly with wires. The knives are merely thin blades of well tempered steel. The slab being brought to the machine is placed longitudinally and in an upright position upon the base board, *b*, where it is balanced if necessary by one hand while the lever-frame is drawn down by the other with sufficient force to make the knives pass through the slab. The bars thus formed fall back upon the shelf, *f*, behind, and are to be removed by a boy to the packing-room, or put at once into boxes. It is, however, better to allow them to remain exposed for a few hours previous to packing or pressing, in order that their surfaces may become very dry. Before repeating the operation, the lever must be raised and hitched by means of its spring catch, *c*, so as to make place for the fresh slab, and be ready to descend upon it with the knives.

If the bars are to be further subdivided into lumps or tablets for the press, they must now be subjected to the operation of the smaller cutting machine, Plate 6, which is of the same construction as the larger one, except that the bars rest against a fixed wooden support, *x*, and do not drop their tablets upon a shelf behind.

The bed-plates of the machine must have cross-cut slits in them to receive the knives after they have cut through the slabs or bars, and at distances apart to correspond with the spaces between the knives. So, also, must



Trübner & Co., 60, Paternoster Row,

Specially designed for Dr. Morfit's Work on S

the support, *x*, be divided by slits at distances apart, as may be required.

A drawer, *d*, serves to receive the scraps, as they may fall or be pushed in during the cutting operation.

It is not the English custom to press soap which is intended for household or laundry purposes. Those kinds are sold in two or two-and-a-half pound bars. In France, however, all the oleic soaps are sold in pound or half-pound lumps pressed into the form of Fig. 26. Owing to the tendency to sweat and become soft on the surfaces when packed in boxes, these are pressed into forms which present as few points of contact as possible. Plate 7 represents the press which is used for the purpose, and it does good work at a rapid rate, one skilled workman being able to put through 600 to 700 lumps per hour. The mould box is shown by *a*, *b*, *c*. The bars having been divided into lumps of half a pound weight, as required, and by the cutting machine, Plate 6, are to be put, severally, in the mould-box, and subjected to pressure by a turn of the lever or balance wheel, *d*. This motion causes the sides and ends of the mould to close on the tablet, and give to it the form and imprint cut upon them. On removing the hand, there is a recoil of the screw, owing to spring-balance arrangement shown by the drawing, and the

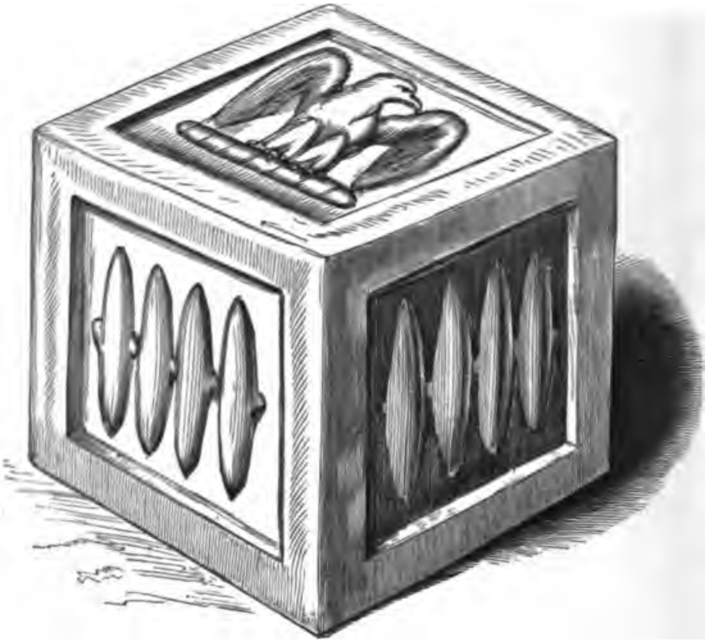


Fig. 26.

mould-box opens its sides to give facility for removing the pressed cake or lump. The term tablet more properly belongs to the cakes of pressed toilet soap, the pressing of which will be explained under the proper head.

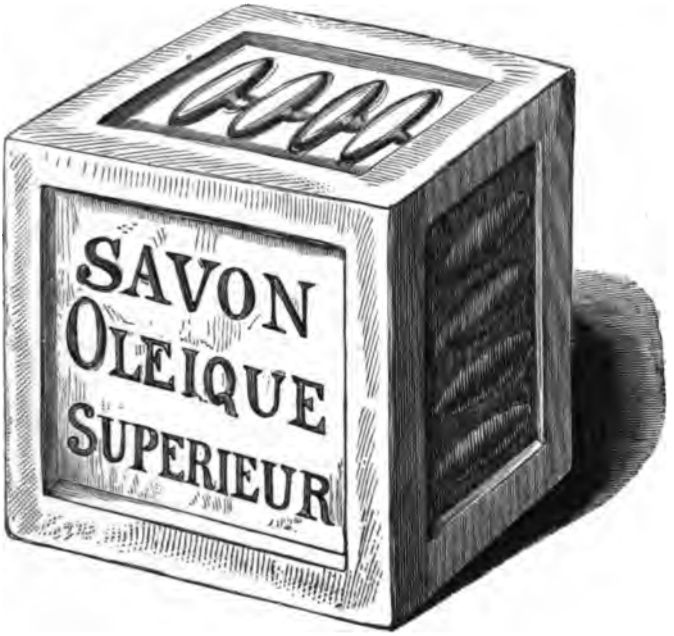


Fig. 27.

The press itself is of iron and steel, the mould-box of brass, and the support, *t*, of oak-wood strongly built. As made by Noel its cost is 16*l.* without moulds. These latter, engraved, cost about 8*l.* for laundry lumps, and 2*l.* to 3*l.* for toilet tablets.

Considering the rapidity with which large quantities of soap can be pressed by this machine, and the more agreeable appearance of pound lumps thus dressed, it is advisable to adopt that form in place of long bars, for all household and laundry soaps. Soap is, also, more convenient for use in such forms.

Figs. 26 and 27 show the half-pound lump of actual size.

CHAPTER VII.

THE FORMULÆ.

THE following formulæ are the results of a long practical experience at my experimental factories in Paris and London, where all the fat acids of commerce, except "recovered grease," were severally tried as fat stock, to the extent of many tons. This so-called recovered grease, or "Wakefield fat," though a mixture of fat acids, was not included in the experimental operations, only because it was inaccessible at the time. The formulæ comprising this grease, therefore, while founded on actual practice, are of very recent construction from a limited experience.

TOILET SOAP.

The chief properties required in toilet soap are great emolliency, hardness, and free lathering and cleansing power.

Emolliency can be obtained by the use of oleic acid alone, and in a degree rivalling that of the best "*savon de laitue;*" but the soap will then want hardness until after having been exposed for some months. Moreover, it requires a small proportion of rosin to give it the desirable suds property; and this addition tends still further to lessen the hardness. Nevertheless, the soap is very superior after having been well dried.

The fat-stock for toilet soaps must be as inodorous as possible, in order to prevent waste of perfume material, and modification of the scents. The white oleic acid, obtained by the decomposing action of super-heated steam on neutral fats, is very suitable for the purpose. This kind may be obtained from Price's Candle Company, Limited, London.

For Windsor, or coloured soaps, Ogleby's oleic acid (London), or Taylor's (Leith), answer well, but they cost higher. They are the only English "oleins" free from empyreumatic odour, except the white of Price's Company. In the use of either one of these "oleins," there should be an addition of some solid fat to give hardness and durability to the soap, but the proportion should be kept as low as possible. The white and brown pressed stearic cakes from cotton oil foots (Nos. 28, 30, page 56), are, as made by the London Patent Oil and Stearin Company, most excellent materials for the purpose; but they must have been deodorized previously by the action of jets of steam through their hot fluid mass.

The oleic acid made by several of the stearic candle manufacturers in the United States, and particularly at Cincinnati, Ohio, being quite free from disagreeable odour, and very bright coloured, are well adapted as fat-stock for toilet soaps. Some use the lime process, others that of sulphuric acid and distillation, while a few decompose the neutral fats under pressure with a small proportion of lime.

Morfit's second and third fractional oleic fats, from cotton oil, possess sufficient consistency for toilet soap stock without the addition of any "stearin" cake. They not only give hard products, but impart an emolliency rivalling that of the celebrated "*savon de laitue*" of Paris. So advantageous is cotton oleic fat for toilet soap purposes, that it would be expedient to prepare it direct, if no other source of supply is accessible, by saponifying refined cotton oil with lime or sulphuric acid after the manner which will be explained in my treatise on "Cotton Seeds and its Derivatives."

There is yet another kind of oleic acid (No. 14*a* of the Table, p. 55), which though very thin is quite free from any disagreeable odour, and will answer, therefore, as fat-stock for toilet soap of darker shades than white. It is obtained simply by the action of sulphuric acid on neutral fats, as will be described in my forthcoming work aforementioned.

Rosin.

The rosin must be of the purest and whitest kind for white soaps. The Windsor soap requires a pure rosin also but of deep shade, in order to secure the normal brown tint to the soap naturally, and without the addition of pigments.

The rosin must be thoroughly melted, and mixed with the fat by sufficient stirring, previous to letting in the alkali.

Alkali.

The alkaline material must be as free as possible from foreign salts or other impurities, otherwise the soap may have a tendency to effloresce. The safer way will be to use the "*dry carbonate of soda of* 98°," made by Chance Bros., Birmingham, for glass manufacturers; or that being inaccessible, then the "*crystallized carbonate of soda*," or "*sal soda*." The equivalent value of the usual three materials is shown, relatively, by the following Table; but the Jarrow ash should be excluded from the formulæ in toilet soaps.

CHANCE'S 98° CARBONATE.	JARROW 52° ASH.	CRYSTALLIZED CARBONATE SODA.
lbs. ozs.	lbs. ozs.	lbs. ozs.
100 0	111 0	290 0

The alkali in toilet soap must be wholly combined with the fat, and, therefore, to prevent any excess, the ratio of that ma-

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terial to 100 of oil should not be greater than—

17 0 pounds	19 0 pounds	50 0 pounds
of	of	of
98° (Chance's) Carbonate.	Jarrow 52° Ash.	Crystallized Carbonate Soda.

First Formula.

The pan is to be charged with—

"Olein" ....white	700 lbs.
Cold-pressed "Stearin" Cake, white	400 „

Heat to 290° Fahr., stir for three to five minutes, and let in, through a strainer, a boiling solution of—

Chance's 98° Carbonate Soda*	185 lbs.
Water	40 galls.

The alkali should not be more than ten nor less than six minutes running into the fat. When all has entered, and the intumescence has subsided below the top of the pan, push back the curb. Continue heating

---

[*] Or 500 lbs. of Crystallized Carbonate Soda, fused in 2 gallons water.

and stirring until the paste becomes homogeneous, and very stiff and dry, and then let in ten gallons of boiling water, or sufficient to thin it to a fluid paste. Continue heating and stirring, as before, until the paste is so stiff and dry that it stops the stirrer, and then shovel it into the cooling frames. After two days, cut into slabs, according to the directions at p. 137, leave them exposed for two days, and then re-melt with sufficient boiling water to make a fluid paste. When it has been heated and stirred to the greatest possible stiffness, it is ready to be framed. Fifteen pounds of white, inodorous, concentrated glycerin should be added with the water which is used at the re-melting.

The product is to be perfumed at the time of framing, and it should not be more than 1650 pounds, or four and a half frames full, at furthest. Two days afterwards, or three at the most, it is ready to be cut and pressed.

This soap is normal toilet soap of excellent quality, but not so acceptable as the following.

Second Formula.

This formula involves the mixing of a solid fat soap with an oil soap, and produces a soap very much superior to the preceding. It also includes the advantages of a small per cent. of rosin.

Put into the pan—

Oleic Acid (Price's)	950 lbs.
White Rosin	60 „

Heat to 290°—300° Fahr., next stir for three minutes, and then let in, during ten minutes, so gradually as to prevent too much intumescence and danger of overflow, a boiling solution of—

Chance's 98° Carbonated Ash	170 lbs.
Water	40 galls.

(Or 450 lbs. "Sal Soda" fused in 3 gallons water).

Heat and stir to homogeneous, very dry stiff paste; then let in fifteen gallons of boiling water, or enough to produce a thin liquid paste, and at the same time add a fresh cuite of soap, to be made as follows:—

Cold-pressed "Stearin"	900 lbs.
Oil	100 „

Heat to 290°—320° Fahr., stir for two minutes, and let in, during six to ten minutes' flow, a boiling solution of—

Chance's 98° Carbonated Ash	162 lbs.
Water	40 galls.

(Or 425 lbs. "Sal Soda" fused in 3 gallons water).

Heat and stir till the paste becomes homogeneous, and very dry and stiff; then shovel out into the cooling-frames. After two days it is to be cut, re-melted with about ten gallons of water, or sufficient to make thin paste, and heated and stirred to extreme dryness and stiffness, so that it may fill about seven frames. One per cent., or thirty pounds, of glycerin may be dissolved in the water of the re-heating with great advantage to the soap.

As each pan of soap should not exceed 1600 pounds, this formula will be worked more rapidly by making the two soaps *at the same time in adjoining pans.* Then it will be only necessary to exchange one half of each soap from pan to pan.

The perfume is added at the time of framing, and in the proportion of four imperial pints to every frame of about 4 cwt. Appropriate formulæ for perfumes are given at pp. 164, 165, and 166.

The calculated composition of this soap will be—

"Olein"	31·70
"Stearin"	30·00
Rosin	3·70
Soda, combined	6·20
Glycerin	1·00
Water, &c. (Salts 0·60)	27·40
	100·00

In this soap the ratio of caustic soda is 9·45 to 100 of oleic fat and rosin.

WINDSOR SOAP.

Formula A.

The fat and rosin must be of brown shade, in order to make this soap of natural colour without the aid of pigment materials. The pressed stearin cake must, therefore, be of the whitish brown quality. The oil may be either that made by lime saponification, or simple sulphuric acid decomposition; and better still, the inodorous bright coloured kind obtained in the splitting of fats by superheated steam. Superior to all, however, would be Morfit's second fractional oleic fat, which, without any addition of solid fat, will give a very hard and remarkably emollient soap. The rosin must be deep brown in colour, but of best quality in other respects. The proportions of materials and the operations are exactly the same as already described. The perfume is No. 9 or 13 of the following.

A very good and cheap fat stock for a Windsor soap of a natural colour and low cost, say about 23*l.* to 25*l.* per ton, yet very free from any excess of water, may be composed as follows:—

Cold-pressed Green Cake of L. P. O. & St. Co.	(No. 27 of Table)	300 lbs.
Black Olein, deodorised	(No. 19 „)	300 „
Recovered Grease (brown) ...	(No. 20 „)	300 „
Rosin	(No. 32 „)	100 „

So, also, a hard, cheap, durable, good soap, of the natural colour of "Brown Windsor," may be made by melting and mixing together thoroughly the following soaps and proportions.

Normal Soap from "Recovered Grease"	600 lbs.
„ „ Candle or Cotton "Olein"...	300 „
Ordinary Soap, from entire natural Palm oil......	300 „

The "olein" soap may be replaced by oilmen's brown soap, made after the ordinary method for common soap. It will be more advantageous to purchase the latter as well as the natural palm-oil soap from the manufacturers of that class of soaps. It should be remarked that the final heating of this mixture must be to very stiff paste, so that the resulting soap may contain as high as 70 per cent. of fat and rosin mixture.

Windsor soap is pressed into tablets of the form and proportions shown by fig. 28.

Formula B.

Very superior Windsor soap may be made in another way, and with all the characteristic emollient property of the oleic soaps of this system. Indeed, this formula gives a rather better product than the preceding in some respects.

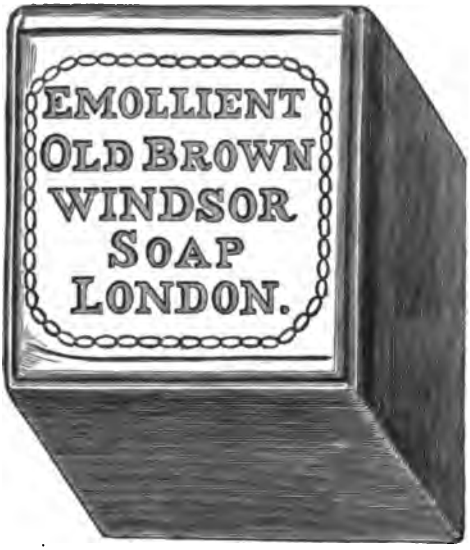


Fig. 28.

The first step is to take crude cotton-seed oil, and treat it with about 2 to 2½ per cent. of milk of lime, for the removal of its black viscous matter, after the method to be fully explained in my treatise aforementioned. The oil is thus rendered fluid, but still retains a black or smoke-brown colour. The next step is to convert it into acid fat, or a mixture of oleic and stearic acids, by either the lime process of saponification, or that of decomposition with sulphuric acid. The fat acids thus separated from their natural base, glycerin, being well washed with water, are then ready for use as the fat-stock of this soap.

Eleven hundred pounds are to be put into the soap-pan (Plate 2), and converted into soap, by means of 200 pounds of Jarrow carbonated ash of 52°, after the manner already explained at pp. 122—128. The product should amount to about 1700 pounds. This soap is then to be framed, cut into bars, reduced to shavings, and mixed with shavings of that kind of household or rosin soap, known by the commercial names of "primrose" and "pale yellow." These soaps are made by the usual methods, and may be purchased in any market at a price ranging from 24*l.* to 30*l.* They must be of first-rate quality for this purpose,—that is, free from excess of water and rosin. The mixture must be made in the proportion of 150 pounds of either "primrose" or "pale yellow" soap to 350 pounds of the oleic soap. That is, for every batch, there must be put into the pan 500 pounds of the old style soap, and 1200 pounds of the soap made, as just directed, with cotton oleic fat. Each must have been previously reduced to thin shavings by the machine (Plate 12), and water must be added in sufficient quantity to produce a very thin paste, at first, so as to ensure perfect homogeneity of the mixture. The heating and stirring are to be done in the usual manner, either of

the pans, Plates II. or III., being employed for the cuite. When the paste has become so stiff and dry as to stop the stirrer, it is finished, and ready to be shovelled into the cooling-frames. The perfume is added at this time, or afterwards when the paste is cold, and in the manner directed at p. 167.

This mixture has, naturally, the proper shade of brown colour for genuine Windsor soap, and will rival in intrinsic excellence the best of the kind that can be made in any other way from tallow or kindred neutral fats. It should be cut and pressed into the forms shown by Plate XIV., rather than after the old style of tablet, fig. 28, which is inconvenient to handle, and much less handsome. The mould may be made to the size of five tablets per pound of soap.

The proportions of the mixture above given should yield a product of 1700 pounds;

and the cost of the soap is so moderate that it may be put into the market, with all its superior qualities, at a price very much lower than that of genuine Windsor soap, and yet with a margin of very large profit to the manufacturer. Its composition will be

Fat	63·00
Rosin	2·00
Soda, combined	6·50
Water	27·00
Foreign matters of ash	1·50
	100·00

"NAPLES SOAP."

A superior toilet soap, approximating closely in appearance and properties to the celebrated "Naples Soap," may be made by this system from the mixed acid cake in its unpressed state, as obtained from tallow or Morfit's, "*jelly fat*," by the lime or sulphuric acid treatment to be described in my treatise on Cotton Seed aforementioned. When jelly-fat-acid cake is employed, it should be with the addition of ten per cent. of stearic acid cake.

Take 1000 pounds of the fat-acids and heat in the pan to 280°—310° Fahr.; then let in, very gradually, a boiling solution of 215 pounds of "salt of tartar" (refined pearl ash) in 40 gallons of water. Continue heating and stirring the mass until it becomes a very stiff, dry paste, and then shovel it into the cooling-frames. The soap may be perfumed during the framing, or after it has been cooled and remelted.

The quantity of fat-acid prescribed in this formula requires, in round numbers, 200 pounds of pure carbonate of potassa; and, therefore the alkali employed must not contain more than five per cent. of foreign salts and matters.

Perfume.

The following formulæ have been constructed with a view to combining delicacy and strength with cheapness of cost. They are numbered in the order of their cost, those which are the most expensive being the most delicate. One imperial pint to each hundredweight of the soap is a good proportion for general use.

No. 1, or Extra.

Strong and Delicate.

Essential Oil of—	Cubic centimetres.
Verbena	100
Lavender	400
Cloves	30
Bergamot	10
Rose Geranium	20
Neroli	20
Santal	15
Tincture of Musk	25

Cost, 12*s*. per lb.

No. 2, Cologne

(*Good*).

Essential Oil of—	Cubic centimetres.
Rosemary	300
Lavender	200
Portugal	400
Verbena	200

Cost, 11*s*. per lb.

No. 3, Bees, Improved.

Essential Oil of—	Cubic centimetres.
Lavender	600
Verbena	100
Orange	100
Cloves	50
Bergamot	20
(Rose) Geranium	20
Neroli	20
Santal	20
Tincture of Musk	50

Cost, 10*s*. per lb.

No. 4, Guimauve.

Essential Oil of—	Cubic centimetres.
Lavender	660
Lemon	130
Verbena	65
Green Mint	15
Petit Grain	40

Cost, 9*s*. per lb.

No. 5, Florida Water.

Essential Oil of—	Cubic centimetres.
Lemon	100
(or Orange) Portugal	100
Lavender	200
Cloves	200
Cassia	10

Cost, 5*s*. 4*d*. per lb.

No. 6, Florida.

Essential Oil of—	Cubic centimetres.
Lemon	200
Orange	200
Lavender	400
Cloves	400
Cassia	20
Tincture of Musk	50

Cost, 5*s*. 4*d*. per lb.

No. 7, Strong.

Essential Oil of—	Cubic centimetres.
Caraway	60
Rosemary	50
Bergamot	10
Sassafras	30
Lavender	180
Cloves	20
Cassia	20
Mirbane	30
Tincture of Musk	20

Cost, 5*s*. per lb.

No. 8, Marie.

Essential Oil of—	Cubic centimetres.
Sassafras	60
Cassia	100
Caraway	100
Bergamot	100
Rosemary	100
Thyme	100
Cloves	150
Lavender	300
Mirbane	60
Tincture of Benzoin	100

Cost, 5*s*. per lb.

Not so good as "No. 10, Brewer."

No. 9, Berry.

(*Windsor*).

Essential Oil of—	Cubic centimetres.
Caraway	160
Bergamot	240
Portugal	40
Cloves	10
Lavender	80
Thyme	80
Verbena	30

Cost, 5*s*. per lb.

No. 10, BREWER.

Essential Oil of—	Cubic centimetres.
Cinnamon	50
Thyme	200
Cloves	25
Lemon	100
Lavender	200
Rosemary	150
Mirbane	50

Cost, 4*s*. 9*d*. per lb.

No. 11, NOSEGAY.

Essential Oil of—	Cubic centimetres.
Bergamot	480
Caraway	320
Orange	80
Cloves	20
Lavender	160
Thyme	160

Cost, 4*s*. 9*d*. per lb.

No. 12, FARRAND'S TWO.

Essential Oil of—	Cubic centimetres.
Lavender	200
(Serpolet) Wild Thyme	200
Cloves	250
Fennel	100
White Thyme	100
Rosemary	200

Cost, 4*s*. 4*d*. per lb.

No. 13, M. WINDSOR.

Essential Oil of—	Cubic centimetres.
Caraway	160
Bergamot	240
Portugal	40
Cloves	10
Lavender	80
Thyme	80

Cost, 4*s*. per lb.

French measures are given, because the subdivisions are more convenient than those of the English ounce. Moreover, the graduated glasses of the laboratory are now generally marked with the French scale.

Perfuming Operation.

In all cases soap is much improved in smoothness and mildness of paste by being remelted. Therefore, after having been cooled, the frame-blocks are to be cut into bars and left exposed for several days. These bars are then further to be reduced to thin shavings by means of the machine shown by Plate XII. These shavings must be put into the pan, thinned out with water to a fluid paste, and heated and stirred until a very stiff dry consistence is obtained. The paste is then ready to be framed, and the perfume is added during the framing operation, it being diffused through the mass by the aid of a crutch or wooden implement shown by fig. 29.

The shaving-machine consists of three iron conical cylinders, *c c c*, upon an iron axle, carrying on their circumference, each, three sharp steel knives, *d d d*, arranged in open slits. The whole is supported upon a strongly built wooden frame, *a*. The pulley, *e*, is for imparting motion, it being driven by steam-power. The inclined planes, *b b b*, in box form and of wood, serve as hoppers or feeders to the revolving cylinders. The bars of soap, being put into these hoppers during the motion of the knives, slide down to the latter, and under the pressure of those which succeed, the nearest bar has its ends rapidly shaved off, and the shavings thus formed fall into the box, *f*, beneath, placed there to receive them. This box should be made of galvanized-iron plate for the sake of cleanliness, and be mounted on wheels to facilitate its movement from

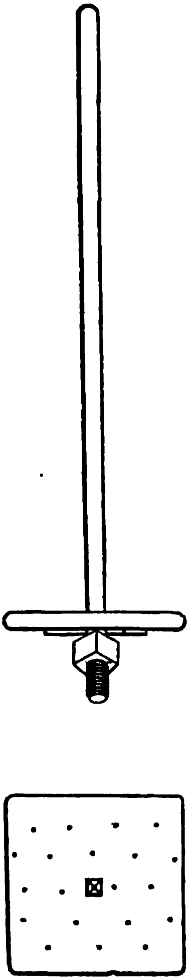


Fig. 29.

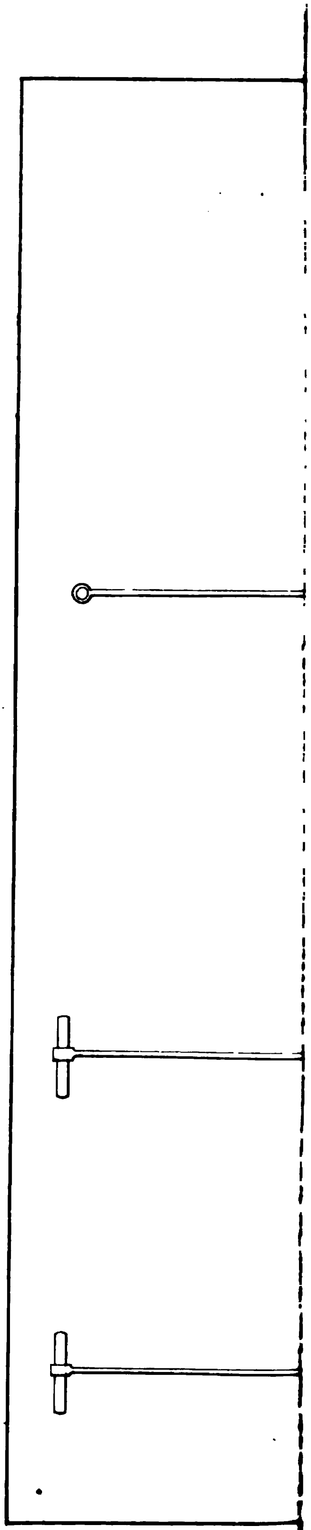
place to place. One workman is necessary to keep the hoppers supplied with bars; and each cylinder will reduce into thin shavings about 200 pounds of soap per hour, with the attention of this single labourer.

For toilet purposes, the soap is not only to be remelted, but again reduced to shavings, and then perfumed in a cold state by the aid of the machine, Plate XIII. It consists of a cast-iron framework or support, *a*, upon which are mounted three cylinders of granite, *c c c*, comprising the grinding-mixer, or *broyeuse*. These stone cylinders are 40 centimetres long, and have a diameter of 18 centimetres.

Preparatory to grinding the soap, and incorporating the perfume and colouring matters by means of these rollers, it must be reduced to thin shavings, for which purpose a revolving cutter, or *déchiqueteur*, *b*, is comprised in this machine. This latter is a hollow, conical cylinder of iron, *b*, 18 centimetres long by 25 centimetres diameter, and fitted with six cutting blades or knives, after the manner shown by A in Plate XIII. The bars of soap are fed to this cylinder by means of the wooden box, *f*, and the shavings cut from them are in turn fed to the stone rollers through the wooden hopper, *e*.

Motion is communicated by means of the fly-wheel, *g*, and the cog-wheels, *k*, *d*. The small wheels and screw-rod arrangement, *h h*, serve to regulate the space between the cylinders, *c c c*, and the position of the *déchiqueteur*, *b*. Lubrication is effected by the oil-cups, *i i i*.

A special box of galvanized iron plate is to be provided as a receptacle beneath the cutter for the shavings as they fall. It is in this box that the perfume and colouring-matter is to be added to the soap. The proportion of the former is one to one and a half per cent., and of the latter eight-tenths to one per cent., of the weight of the soap. Whether powder



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or liquid, the colouring-matter should be always mixed previously with the perfume by thorough stirring; and to insure the better diffusion of the perfume throughout the soap-paste, the essences or extracts used for the purpose should be diluted with a little alcohol. The paste thus treated is to be put into the hopper, *e*, and made to pass through the rollers, *c c c*, as many times as may be necessary to render it perfectly smooth, uniform, and elegant in appearance. Sometimes six repetitions are necessary to this end.

The ribbons of soap dropping from the *broyeuse* are finally to be kneaded and rolled with the hands upon a marble slab into cylinders, and then divided into forms of the required weight and size for pressing into tablets.

A machine of this description, for working one ton of soap per day, costs 35*l.*; but a larger one, requiring steam power of one horse to drive it, can be bought for 44*l.*

Vermilion, rose-pink, yellow ochre, brown ochre, gamboge, burnt sienna, are the usual colouring powders; but the more brilliant and convenient coal-tar dyes are coming into vogue.

Cutting and Pressing.

The soap for toilet purposes is pressed into a variety of forms, according to the taste of the manufacturer and the caprice of fashion. They may be oblong tablets of greater or lesser thickness, and with or without angular corners. As a general rule, however, the tablets or cakes, if too thin, are not economical, for in that form they wear away rapidly in the water. Then, too, the edges should be bevel-rounded, this shape being more pleasant to handle in washing.

Naples soap has the special form of a round disc about three-quarters of an inch thick. So, also, is the Windsor soap pressed into a particular shape, as shown by fig. 28, which represents a facsimile as to form, dimensions, and device of the actual cakes made and sold by the house, in London, most celebrated for this kind of soap.

All the toilet soaps must be pressed very hard. The cutting is done by the machines, Plates 5 and 6, and in the manner described at pp. 133 to 140; but, as the tablets are comparatively small, the number of cutting-knives must be increased for this purpose, in each of the machines. By this arrangement a large number of cakes may be cut at one and the same operation.

For quick, common soaps and *angular* cakes, the press, Plate 7, will answer very well, and do its work rapidly; but there must be a special mould-box for each size and form of tablet.

Soaps of finer quality require to be pressed very hard, in order that the tablets may have a handsome finish. For these, the mould-box, *a*, fig. 30, is necessary. It is made of bronze, and consists of two portions—the upper held by a catch-spring in a matrix at the end of the screw portion, and the lower

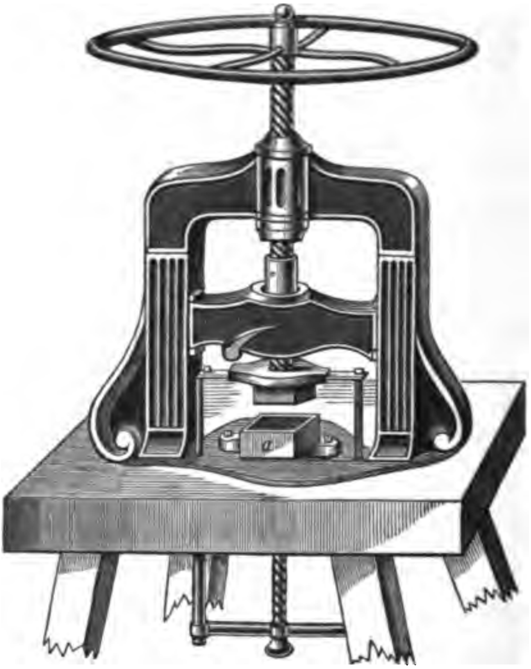

Fig. 30.

fitted into a similar cast-iron matrix on the bed of the press. Beneath this matrix pass two lever rods, *r r*, connected at their upper ends with the press-screw, and at their lower with a movable tampan, *t*, which, after each pressing, throws up the mould from the matrix, and thus facilitates the removal of the cake of soap. The tablet of soap should be rubbed over lightly with alcohol, if it is desired to give a polish to the pressed cake.

A form of tablet originated by the author is shown by 1, 2, 3, Plate XIV. It is a flattened ball with round bevelled edges, this shape being very elegant, as well as convenient for handling in the wash-basin or bath. The imprint upon the surfaces may be according to the judgment and taste of the manufacturer; but, suggestively, the figures 1 and 2 of the Plate present a design embodying the monogram of the manufacturer, the style and locality of the factory, the date of the soap patent, and a trade mark. The letters are to be upon the surfaces of the mould. Noell, of Paris, and Houtchins, of London, make and engrave this kind of work in superior style.

The drawings are to the full size of the actual tablets to be made and sold for the purposes of the bath. Those cakes or tablets intended for toilet purposes should be one-third smaller. The lower half of the mould for my form of cake is given by fig. 4 of the Plate, and the upper corresponds with it in form and dimensions. As a general rule, toilet soaps, in the London trade, are pressed into tablets of two, three, four, five, six, seven, and eight ounces to the pound of soap. The press itself is not very unlike that shown by fig. 30, and costs 16*l.*, with 2*l.* additional for an engraved mould of bronze. The Windsor, Naples, and other different forms of tablet must have, of course, their special moulds.

The French tablets vary in proportions, but those most common are of 70 to 80 grammes weight, eight to eight and a half centimetres long, five to five and a half centimetres broad, and two and a half to three and four and a half centimetres thick.

SOAP FOR SILK-DYERS.

This soap, commercially known, as "*Brown Oil Soap*," is used largely in Macclesfield, Coventry, Leeds, Nottingham, and Spitalfields, London, for "STRIPPING AND BOILING OFF" SILK, AND IN THE DYEING PROCESSES. It must cleanse readily without injuring the silk, and have the property of being easily rinsed out. For "*stripping and boiling off*" especially, the soap must be very soluble. This quality is imparted by the use of "brown oil" alone; and the distilled and deodorized "olein" of the Patent Oil and Stearin Company, Limited, may be employed advantageously as the fat stock.

The oil stock of which Field's soap is made thickens only at 52° Fahr., and this olein of the Patent company approximates to it in that respect. At the same time, any "olein," or crude oleic acid of good quality from the stearic candle manufacture, or the "oil foots" distillation, will answer equally well for this kind of soap.

It may be remarked here that Field's soap is much approved by silk-dyers, as is also the soap of this formula; and that there are no other manufacturers who can produce soaps of corresponding characters.

A prompt cleansing power is given by the use of a small excess of alkali over and above the combining proportion; but to protect the silk from any injurious action it might possibly exert during the "*boiling off*," an intermediate material is added in this system. This is sulphate of soda. The cheapest commercial form of sulphate of soda is the residue from the manufacture of oil of vitriol, known as "*nitrate cake*," and it can be had abundantly at any oil-of-vitriol works. It will be more convenient, however, and not much less economical, to use the commercial dry sulphate of soda, made for glass-makers by the Jarrow Chemical Works, Newcastle, England.

In "*boiling off*," four pounds of soap are taken for twenty pounds of silk. The shorter the time it requires to remove the gum, the better the soap; always provided that there is no injury to the fibre of the silk during the process.

In some exceptional cases, and as regards particular kinds of silk, the appearance after "*boiling off*," with soap containing sulphate of soda, is not that required by some dyers. For such cases, then, the sulphate must be omitted, the ratio of Jarrow ash reduced to 240 per 1000 of fat, and a proportion of cold pressed stearic cake employed; say, oil 850 and solid fat 150, or, better still, Morfit's fractional oleic fats alone.

For dyeing purposes, particularly as to black silks, the normal soap of oil and sulphate is very superior in every respect.

Formula.

Put into the pan—

Redistilled "Cotton Olein" or "Candle Olein"	1000 lbs.

Heat to 280°—290° Fahr., and then allow to flow in, during six to eight minutes, a boiling solution of

Jarrow (52°) refined Ash	215 lbs.
Water	45 galls.

Heat and stir to stiff paste. At this stage it is ready to receive the "stripping," which is made as follows:—

Put into the feed-pan above—

Dry Sulphate Soda	78 lbs.
Jarrow (52°) Ash*	35 "
Water	12 galls.

Boil to perfect solution, and add then—

Ammonia Alum	9 lbs.
Urine	2 galls.

The liquor is then to be allowed to run into the soap-paste below, during constant

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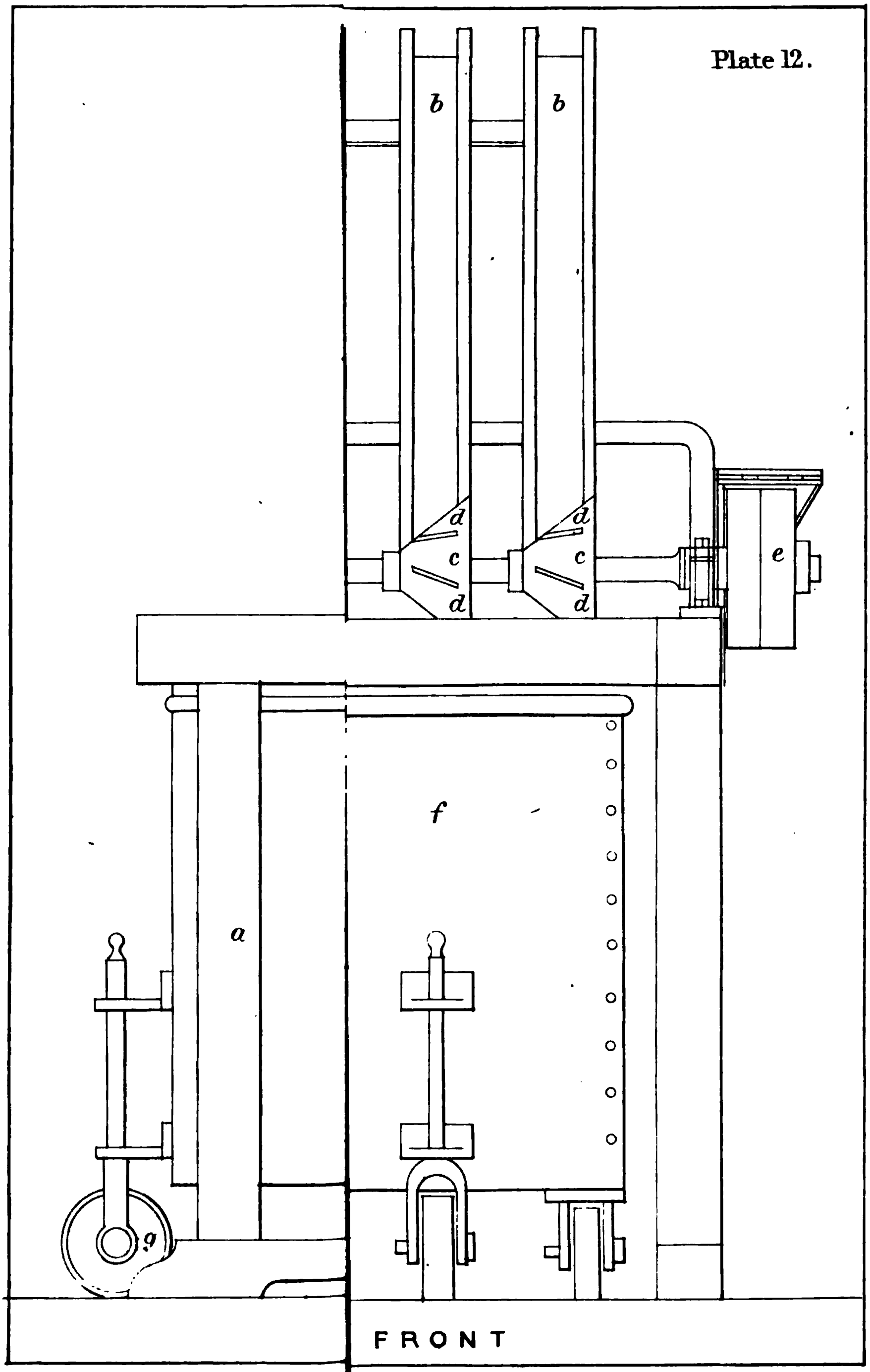
* For hard-water countries, like Macclesfield, the proportion of ash should be increased to 50 pounds.

Plate 12.



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Specially designed for Dr Morfit's Work on Soaps

heating and stirring of the latter. When the paste has become stiff and dry, or equivalent to about 1650 to 1750 pounds, it is to be shovelled out into the frames. This degree of hardness is sufficient to mask the presence of sulphate of soda; and if the cooking should be carried further, then it will be difficult to cut the soap even so soon as the second day after it is framed. The time consumed in bringing it to the required degree of stiffness is three to four hours after the addition of the stripping liquor. The super-heater must be kept at a violet heat from the first to the last step.

If the "*nitrate cake*" should be used instead of dry sulphate of soda, then to make the stripping of this material, put into the feed-pan—

"Nitrate Cake"	75 lbs.
Water	12 galls.

Bring to boiling, and add *gradually* Jarrow (52°) ash until all of the free sulphuric acid is neutralized. This requires from ten to seventeen pounds of ash, according to the quality of the cake; and the point of neutralization is attained when effervescence ceases, and the liquor turns a piece of red litmus paper blue. This done, then add—

Jarrow (52°) Ash*	35 lbs.

Boil to solution, and then further add—

Ammonia Alum	9 lbs.
Urine	2 galls.

When the whole has been boiled to solution, it is to be let into the paste as just directed for the dry carbonate soda liquor, and the cooking and stirring are to be continued until the paste is stiff and dry, and amounts to about 1650 to 1750 pounds, or say four and a half frames full. This generally requires three to four hours, even with a hot super-heater; for the addition of the stripping renders the paste thin to fluidity. Some six hours are required, at best, to complete a cuite. If the soap is too little cooked, or less stiff and dry than prescribed, then its contained sulphate of soda is apt to show itself in crystals upon the exposed surfaces of the soap after it has been cut; whereas, in the contrary case, the paste is very handsome and hard.

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* For Macclesfield and other hard-water districts the proportion of ash should be raised to 50 pounds.

This soap will have the following composition:—

"Olein"	58·00
Soda, combined	5·80
Water	27·70
Stripping (dry) with Salts of Ash.	6·00
Free Ash	2·50
	100·00

The ratio of combined soda is equivalent to 19·50 ash per 100 of oil. The ratio of total ash is 25·00 per 100 of oil.

This soap, when the paste has been heated to extreme stiffness, is a rock-like product, admirably adapted for exportation or shipping purposes; and it washes well even in cold water. It must therefore be cut the day after being framed.

The stripping-soap is sold for 33*s.* 6*d.* to 34*s.* per cwt., from which is to be deducted two and a half per cent. discount, 1*s.* commission, and the cost of transportation, the custom being to deliver it free.

SILK-THROWSTERS' SOAP.

Soap for silk-throwing must be white and free from odour, or, in other words, similar in appearance and qualities to the best "curd" soap of the usual processes. By the use of a carefully prepared "Morfit third fractional oleic fat" a very superior soap in all respects but purity of whiteness can be made according to the formula for Normal soap, at p. 132.

FAMILY AND LAUNDRY SOAP.

The requisite qualities of a soap for laundry and household purposes are—

1. Facility of cleansing without injury to the clothes or harshness to the skin, whether in cold or warm water.

2. Durability or wearing property, even in warm water, and at the same time of giving a free and rich lather.

3. Of making the labours of the laundress as little fatiguing as possible, by doing the cleansing without the necessity of rubbing the clothes hard.

All the foregoing desiderata are characteristics of the soaps of my system. All soaps made by it are peculiarly mild to the skin, and yet powerfully cleansing in their effects. To impart hardness and durability in an eminent degree, the fat stock is made up of a due proportion of solid fat, just sufficient to accomplish these properties without impairing the quality of solubility imparted by the brown-oil ingredient. A free lathering quality is given by the addition of a limited quantity of rosin to the fat stock.

In Great Britain and the United States the market is held by a species of pale yellow soap, known and sold under the several names of "primrose," "pale yellow," "extra," "No. 1," &c.; but they all contain variable proportions of rosin and excess of water. On these accounts, and also because they are mostly made of low grades of fat stock, such as cheap tallow, bone grease, or kitchen stuff, the market price for them is seemingly low, viz., 20*l.* to 30*l.* per ton without boxes. By exposure, however, they soon dry down to a much diminished weight, and become so hard that they will not wash or lather freely in cold water, nor yet do laundry work without the aid of some "sal soda," or crystallized carbonate of soda.

The economy, therefore, is greatly in favour of the soaps by this system, which are hard from the first, and inalterable simply on account of their being made of the purest ingredients, only, in their normal or exact combining proportions. They are, however, though superior in quality, of less bright colour than the usual British and American soaps. Therefore, it will not be until after the prejudice of habit in this respect has been overcome by a fair trial, that these soaps can assert their greater advantages for household purposes. Once used, however, their very superior excellence will secure for them ever afterwards a preference. It is their intrinsic qualities which are most remarkable; but they have, also, a sufficiently handsome appearance.

First Formula.

Put into the pan—

Oleic Acid, of bright colour	650 lbs.
Solid or cold-pressed "Stearin" Cake ...	350 „
Bright Rosin	50 „

Heat together to 293°—300° Fahr., stir for *three* minutes, and then let in, during a flow of eight to ten minutes, a boiling solution of—

Jarrow (52°) Ash.............................	210 lbs.
Water	45 galls.

Continue the heating and stirring until the paste becomes stiff and dry; then let in ten gallons of boiling water, and further continue the heating and stirring until the paste is very dry and stiff. It should make four frames full, equivalent to 1600 pounds.

The ratio of ash in this formula is 20·0 pounds per 1000 of fat and rosin mixture. When the soap is intended for *laundry* purposes, the ratio should be increased to 21·50, or 225 pounds for the cuite.

The composition of the soap will be, per cent.—

"Olein"	40·62
"Stearin" Cake	21·86
Rosin	2·90
Soda, combined	6·55
Water	26·77
Salts, &c. Free Ash	1·30
	100·00

The ratio of caustic soda is 10·0 to 100 of fat-acid and rosin.

Second Formula.

1. To provide against any possible tendency to efflorescence, which the soap of the preceding formula might have, possibly, under certain conditions of climate, it will be better to make it by a double or mixed operation as follows. In such case the appearance of the soap is also improved nearly to that of hard toilet soap, with smooth surface and great fineness of paste.

Put into the pan—

"Olein" (bright)	325 lbs.
"Stearin" Cake	625 „
Bright Rosin	50 „*

Heat to 290°—300° Fahr., stir for three

---

* The proportions may be changed so as to cheapen the cost of the soap without degrading its quality, except in a slight degree as to hardness. Thus—

"Olein"	300 lbs.
"Stearin" Cake	600 „
Bright Rosin	100 „

In this case the alkali must enter at a slower flow, otherwise the boursoufflement may be so great as to endanger the overrunning of the contents of the pan.

minutes, and let in, during flow of eight to ten minutes, a boiling solution of—

Jarrow (52°) Ash	200 lbs.
Water	45 galls.

Continue heating and stirring until the paste is quite dry and very stiff; at which stage, shovel out one-half into a wooden tub.

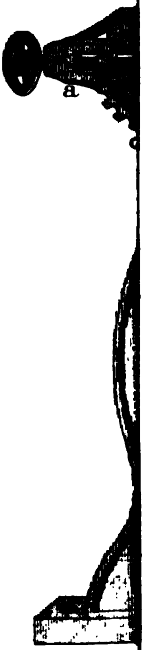
2. While this first step is in progress, put into the adjoining pan—

"Olein" (bright)	900 lbs.
"Stearin" Cake	50 „
Bright Rosin	50 „

Heat the mixture to 290°—300° Fahr., stir for three minutes, and then let in, during a flow of eight to ten minutes, a boiling solution of—

Jarrow (52°) Ash	200 lbs.
Water	45 galls.

Continue heating and stirring until the paste becomes well united, homogeneous, and dry. Then shovel out one half into the adjoining pan, and replace it by the half which was shovelled from this latter into the



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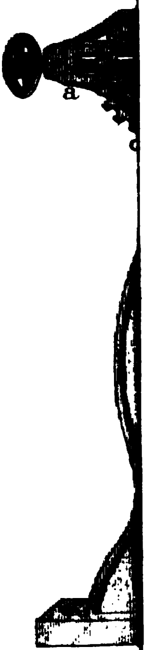

Trübner & Cº, 60 Pa

wooden tub. The two pans are then ready to be treated alike as follows :—Let into each pan six to ten gallons of boiling water, so as to thin the paste to fluidity, and continue the heating and stirring until the contents have become extremely stiff and dry. Then shovel out into the cooling-frames. The product from each pan should fill four frames containing, severally, about 400 pounds, and making a total from both pans of eight frames, or upwards of 3100 pounds.

The cost and shade of this soap will depend upon the kind of olein and stearin and rosin employed. Its composition will be—

"Stearin" Cake	59·90	21·75	63·15
"Olein"		38·15	
Rosin		3·25	
Soda		6·71	
Water		28·59	
Salts, &c.		1·55	
		100·00	

The ratio of caustic soda is 10·60 to 100 of fat-acid and rosin.

Third Formula.

This kind of soap may be made also after another formula, as follows:—

Put into the pan

"Stearin" Cake	400 lbs.
Bright Rosin	200 "

Heat together to 290°—300° Fahr., stir for three minutes, and then let in *slowly*—say during a flow of twenty minutes—a boiling solution of

Jarrow (52°) Ash	115 lbs.
Water	20 galls.

At about forty minutes after all the alkali is in, and the mixture has assumed the condition of a rosin-looking, soft paste, then let in 18 gallons of boiling water. The mass becomes very thin and white. Continue heating and stirring for one hour. At this stage or period, the paste has become homogeneous and well combined, as well as dry-looking, though it is yet rather soft. At this moment, add to it one half of a cuite of soap (800 pounds) made as follows and simultaneously, if convenient, in the adjoining pan, No. 2.

"Olein"	1000 lbs.
Bright Rosin	10 "

Heat to 290° Fahr. stir for three minutes, and add boiling solution of

Jarrow (52°) Ash	190 lbs.
Water	40 galls.

Stir and heat in usual manner to the condition of a homogeneous, dry, stiff paste.

When the half cuite of No. 2 pan has been shoveled into the cuite of pan No. 1, five to ten gallons of boiling water are let into the mixed pastes, so as to blend and soften them, say to thin mush; the heating and stirring are then to be continued until the paste becomes dry and stiff or equal to 4½ frames full, or say 1700 pounds at most.

The composition of this soap will be as follows:—

"Stearin" Cake	53·00	23·50	65·00
Olein		29·50	
Rosin		12·00	
Soda		6·50	
Water		27·20	
Foreign Matters		1·30	
		100·00	

This soap gives a lather of great richness, and washes with the least possible waste of soap and labour. Its ratio of caustic soda is 10·0 per 100 of fat, acid, and rosin.

Formula IV.

Better than any of the preceding fat mixtures would be Morfit's "second fractional Oleic fat." This is to be converted into soap after the usual manner, by using 20 pounds of Jarrow ash to every 100 pounds of fat, and then, while in the state of hot paste, adding thereto and stirring in, during continuous heating 15 per cent. of rosin soap made as directed at Chapter VIII. When the whole has become homogeneous and stiff paste, it is to be shoveled into the cooling frames, and in proper time cut for market. This soap is hard emollient, clean-looking and superior in both suds and cleansing properties.

In all these formulæ, the rosin may be added in the form of rosin soap after the fat soap has come to paste in the pan, instead of being melted with the "olein" at the first step of the operation. This plan has some important advantages, and the mode of operation will be described in Chapter VIII.

BROWN OIL SOAP, FOR FULLING OR MILLING WOOLLEN CLOTHS.

THIS soap being chiefly used by the cloth manufacturers of the west and north of England, and Eastern States of the American Union, it must have a good stiff body and be slightly strong in alkali. The excess of alkali, however, should not be so great as to "*bleed*" the color of fine dyed wools.

This soap must have the property of jellifying promptly:—that is its solution in boiling water must cool to a jelly in a reasonably short time.

The method of applying this test, in the cloth-factories, is to put 112 pounds of soap into 80 imperial gallons of water, and then boil by steam until a perfect solution is obtained. Cold water is now added until the volume reaches 170 gallons. This liquid soap will set in about twelve hours.

On a small scale, the experiment may be tried with one ounce of soap in seven and a half fluid ounces of water over a gas flame; and then adding to the hot solution, sufficient cold water, to make sixteen fluid ounces. This solution should become jellified within a half hour, or as soon thereafter as it is quite cold.

When a soap has this jellifying property in requisite degree, it is then all the better for cloth-milling purposes, the more soluble it may be.

The custom of many of the manufacturers is to use a mixture of " Brown Oil Soap " and "mottled soap," in the proportion of 9 cwt. of the former costing 34*l*., and 6 cwt. of the latter costing 30*l*. per ton. The fat stock of such a mixed soap has a congealing point of 85° Fahr. Therefore to imitate such a consistency, in making a fulling soap by this system, there must be used seven pounds of solid fat acid, or cold pressed " stearin " with every fourteen pounds of "Brown Oil" or crude oleic acid. In other words, one-third solid and two-thirds fluid fat, are to constitute the fat stock.

The following table gives the composition of soaps of these kinds, as determined by actual analysis, together with that of the soap of this system, as deduced from the formula which is about to be described.

Components.	Price's* Co.'s Brown Oil Soap, 10 *months* old.	Rowe's† Mottled Soap, 10 *months* old.	Morfit's Milling Soap, *freshly* made.
Chlorid and Sulphate Sodium............	...	1·01	...
Fat	72·50	70·50	65·00
(Melting or congealing at ° F.)...	(74°F.)	...	(84°F.)
Soda, combined	7·04	6·84	6·50
Water	19·96	17·90	27·10
Salts and insoluble residue	0·30	2·35	1·40
Carbonate Soda, free	...	1·05	...
	100·00	100·00	100·00
Total Carbonate Soda to 100 Fat	16·50	16·60	16·65
Ratio of combined Soda to 100 Fat ...	9·71	9·70	10·00

The Yorkshire cloth manufacturers require a soap rather stronger in alkali than those of the west of England:—say 205 pounds of Jarrow (52°) ash to every 100 pounds of fat acids.

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* Brown Oil Soap, if fresh, would show 10 per cent. less of fat, and that much more of water.

† The normal composition of this kind of soap is shown by the analysis of a fresh sample from Cowan's works, on p. 200.

The solid fat to be employed may be the cold pressed stearic cake from Cotton Oil Foots: and the oil may be the redistilled, deodorized oil from the same source. Care must be taken to insist upon the oil being deodorized by the manufacturers.

To make the soap, put into the pan,

Cold pressed "Stearin"	300 lbs.
Oleic Acid	750 „

Heat to 290° Fahr., stir for three minutes, and let in boiling solution of,

Jarrow (52°) Ash..................	210 lbs.
Water	45 galls.

Continue heating and stirring to the condition of an homogeneous stiff paste of great dryness, equivalent to 4 frames at least, or about 1650 pounds.

This soap will have the composition recorded in the table on page 198. It sells for 36*l.* per ton delivered, less 2½ per cent. discount.

This soap can be made also, and perhaps of better quality from equal weights of Morfit's second fractional cotton oleic fat and ordinary candle or cotton foots "olein;" or from the second fractional fat alone.

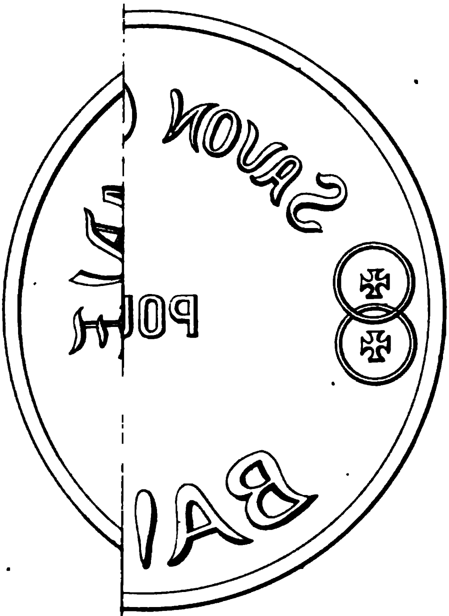
Second Formula.

Some woollen cloths, such as piece-dyed black, require a great deal of milling, in order to be able to stand the very severe process of finishing; and "mottled soap" alone is the kind often employed for this work. A sample of *freshly* made mottled soap obtained from one of the principal manufacturers of cloths in Yorkshire was found to be composed of:—

Insoluble matters (accidental)	1·10
Carbonate Soda (free)	·60
Water	29·10
Fat (melting at 93° F.)	62·90
Soda (combined)	6·30
	100·00

Plate 14.

2.



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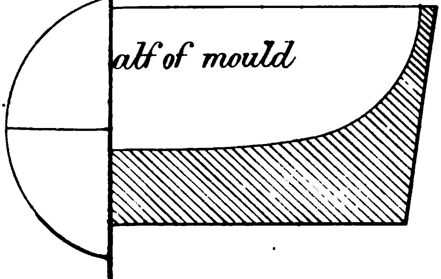

Trübner & Cº, 60, Paternoster Row.

Specially designed for Dr Morfit's Work on Soaps

To make soap of the same nature and composition, but with all the superior excellence to be imparted by my system, it is only necessary to proceed as just directed in the preceding formula, and with the same materials in proportions as follows :—

Cold pressed "Stearin"	450 lbs.
Oleic Acid	650 „

Heat to 290°—310° Fahr., and treat with a boiling solution of,

Jarrow (52°) Ash..................	235 lbs.
Water	60 galls.

Continue the heating and stirring until the paste becomes stiff and dry, and then shovel it into the cooling frames. The product should amount to about 1800 pounds.

Morfit's second fractional cotton oleic fat may be substituted, with advantage, for the mixture of stearic cake and oleic acid as above prescribed.

SOAP FOR MANUFACTURERS OF WOOLLEN CARPETS.

The Kidderminster Carpet Manufacturers require a soap of good fat body and considerable alkaline strength. It must wash out quickly and not mill. Field's "*Brown Oil Soap*," at 34*l.* to 36*l.* per ton, is generally used.

The wool being from Russia and the East Indies, requires a very strongly alkaline soap to wash out the contained lime.

The fat mixture for this soap should be therefore

Olein, redistilled and deodorised	950 lbs.
Solid Fat Acid	50 "

Heat to 290° Fahr., stir for two minutes, and let in boiling solution of

Jarrow (52°) Ash..................	250 lbs.
Water	55 galls.

Heat and stir continuously until the mixture has become a stiff dry paste, and then let in ten gallons boiling water; and further heat and stir until the paste is well bound and very dry and stiff. The product is equivalent to about 1600 pounds, or four frames full.

This soap will have the following composition:—

Solid Fat Acid	3·12
Oleic Acid	59·50
Soda, (combined)	6·30
Water	26·85
Free Carbonate Soda	2·40
Salts of Ash	1·83
	100·00

OLIVE SOAP.

GOOD AND CHEAP FOR THE SHIPPING TRADE.

The stripping soap for silk dyers' use, as made at p. 177, may be converted into a very good and cheap export soap for ordinary purposes, by mixing it with rosin soap. It is only necessary to put 1200 pounds of the stripping soap into the pan, bring it to a hot soft paste by heating and stirring it with sufficient water, and then adding, during constant stirring and heating, 500 pounds of the rosin soap. The addition of fifty pounds of palm oil soap will improve the colour. When it has become stiffish brown paste, shovel it out into the cooling frames.

This soap hardens promptly, does not effloresce, and washes well. The product should amount to about 1600 pounds, or about four frames full.

The quality of the product will be very excellent, and its cost is low.

SAVON AFCLI.

The afcli soap is best and most economically made with a mixture of soaps from "recovered grease," black cotton olein, and rosin soap.

Commence by making the soap as follows:—

1. With recovered grease, 1000 pounds, and Jarrow carbonated ash, 200 pounds, in water 45 gallons. Heat the oil as usual to about 290°—300° Fahr., and let in the boiling solution of ash, slowly, on account of intumescence. The usual paste is at first formed, but becomes very thin subsequently, and remains so. Frame as fluid paste after about twenty to thirty minutes heating from the time the alkali has entered, or as soon as a drop cooled on paper sets well. .It hardens well in the frames within twenty-four hours.

2. Make a batch of soap in the same manner as above, and with corresponding proportions of black cotton "olein," Jarrow ash, and water. Cook in the usual manner, and frame when the paste has become homogenous, though still soft.

3. Take 800 pounds of the recovered grease soap, heat and stir together with 400 pounds of the "olein" soap, and then add thereto 600 pounds of rosin soap. Heat

and stir to perfect homogeneity; and as the paste stiffens, let in a boiling solution of 200 pounds of dry sulphate of soda in 40 gallons of water. Continue heating and stirring until a sample portion of the paste ceases to cool opaque or creamy, and is well advanced to translucency. At this point it is ready to be shoveled, or rather, dipped out into the cooling-frames.

This soap is rather long in progressing to completion; and it is sometimes thirty-six to forty-eight hours after having been framed before it becomes sufficiently hard for cutting. But it washes well, suds well, and is of the right shade of color and cheapness for the Algerian and West Indian markets. Moreover, it is free from animal fat, which is also an important consideration in reference to the religious prejudices of the Algerians.

The amount of product should be about 1800 pounds, costing about 14*l.* per ton, and composed approximately as follows per cent. :—

Fat	43·00
Rosin	18·00
Soda	9·50
Water	27·80
Foreign Matters	1·70
	100·00

CHAPTER VIII.

ROSIN SOAP.

THE rosin soap, prescribed in several of the formulæ, though not, in itself, a practical washing soap, is a veritable compound of the rosin acids with soda, assimilating so closely to true soap in many properties, that it may be considered a justifiable diluent of the latter to a certain extent. Indeed, in as high a proportion as twenty per cent., it is a beneficial addition to fat soaps when its cheapening effect is also taken into consideration. In many factories, however, its use is carried to such a great excess as to be in conflict with the interests of the consumer. It is only by judicious combinations of fat stocks, and rare skill in the manufacturing operation, that dry soap of even fair quality, can be made to carry more than twenty-five per cent.; and then the price to the consumer should fall nearly in proportion to the rise of the content of rosin.

The presence of rosin in fat soaps, particularly those of my system, prevents any tendency to efflorescence, and promotes the retention of a large amount of water.

The most convenient and suitable form of rosin soap, for mixing with soaps of any system, can be made with facility after the following directions.

There should be a special and spacious pan for the manufacture of this soap in a large quantity at a single cuite or boiling, and a most suitable arrangement would be that patented by me in 1856, and now much used for operations in which heating and stirring are required to go on concurrently. Plate XV. shows it as made by Murril and Keizer, Baltimore, Maryland, United States of America. It consists of a stirrer, A, with tubular iron blades heated by a current of steam entering from the boiler, B, through the steam-box, C, and passing back when condensed through the box and tube, D. Motion is imparted to the stirrer by means of the pulleys and cog-gearing, E, F. The stirrer is fitted to a pan, G, which may be of wrought or cast iron. The heating surface of the tubes is not sufficient to produce a higher temperature than 212° Fahr. By cullendering the tubular blades, that is piercing them with holes, and omitting the lower steam-box, D, and boiler connection, so that the steam may be injected directly into the contents of the pan, this twirl becomes a most convenient apparatus for boiling fat soaps by the usual or old methods with the least expense of fuel, time, and labour, and the maximum perfection of product.

The finished soap is generally dipped out; but this manipulation is laborious and time-consuming, especially in connection with pans of large size, and therefore it would be advisable to fit it with an elevator or monte-jus arrangement, after the design of Gossage. It then becomes self-emptying, and a most efficient apparatus in all respects for boiling the rosin soap under description, and indeed all other kinds for which the usual method of manufacture is followed. My oleic soaps form an exception, because their paste, when finished, and even in the hot state, is much too stiff to be lifted by a monte-jus into the cooling-frames.

Plate XVI. will show how the arrangement is to be applied. A is the boiling-pan of cast or wrought iron, to which is fitted tightly a cover, B B′. Part B′ of this cover is permanent, the other B being moveable and hinged on at C when in use. The edge of B is grooved all the way round, and into this groove is fitted a continuous band of india-rubber, E, by which it rests on the rim of the pan and the ledged end of B′; screw bolts, F F, serving to compress the joint. The joint around the stirrer must also have an india-rubber appliance to make it tight when the monte-jus is to be put into action.

A pipe, G, passes through two stuffing-boxes, H, I, one affixed to B′, and the other adjusted to a larger pipe, K. The pipe, G, is open at top, but has its lower end closed and cullendered for the passage of liquid matters. A portion, G′, of this pipe has a male screw formed on its outer surface; and attached to the fixed portion, B′, of the lid, there is a bridge-piece, L, which has at L′, a female screw encircling the male screw, G′, on the pipe, G. This arrangement allows the pipe, G, to be raised and lowered into the pan at will, by means of a lever, O, it being only necessary to turn it round to the right or left, and into any portion of the pan's contents which are to be drawn out. The cooling-frames into which the soap paste is to be mounted, may be placed in an apartment distant from the boiling-pan, but in that case, gutters leading into them must be provided. A stop-cock at the upper end of K, serves to regulate the outlet of the paste into these gutters.

To provide for the withdrawal of any spent lye or other fluid, deposits incident to the usual methods of boiling soap, a pipe, M, dipping nearly to the bottom of the pan, is fitted to the cover portion, B′.

The monte-jus, or elevator, is put in action for mounting the soap, when the latter is finished and still in warm thin paste. The cover being put in place, with its joints tightly closed by means of the screw bolts, F F, high-pressure steam or compressed air is let into the pan through the pipe, N, so that it may press upon the surface of the fluid paste in the pan, and force it over into the cooling-frames through the pipe G, or M, according as one or the other may have its cock open.

The diameter of the pan should not exceed eight feet, but its depth may be twelve feet. The stirrer and heater are to be fitted as shown in Plate XVI., and, as thus constructed, the pan is a very great improvement upon those now in use; and largely economizes both time and labour in the manufacture of all soaps made by boiling after the methods generally employed, as already noted. The arms, or rather tubes of the stirrer must be pierced with holes, however, for the direct entrance of the steam into the contents of the pan, and in such cases also, the lower connection with the generating boiler, must be cut off.

For what is termed *dry boiling*, or that in which the heat of the steam is to act indirectly through metallic surfaces, the twirl must have its tubes closed as shown in Plate XV.; or a jacket-pan (Plates II. or III.) must be employed. For the rosin soap, now under description, the tubes are to be closed; that is, the steam is only to be allowed to impart its heat through the metal of the tubes, and being thus wholly or partly condensed, to run down and back into the generating boiler.

For the preparation of the soda lye, there must be provided a vat, Fig. 31, of wood lined with lead. It must have a close cover to prevent the access of air and deterioration of the lye; but with a hinged cover for the entrance of the soda and water. An open steam-pipe, *a*, of iron, and with leaden branches, *c c c*, is fitted to the interior as the heating medium. A cock, for drawing off the settled lye, free from sediment and clear, must be placed at *d*. As the alkali is very apt to cause the cock to set fast, at times, this annoying contingency may be avoided by the use of that kind of cock constructed as shown, by Fig. 32, in elevation and section. A is the inlet, and B the outlet. An india-rubber diaphragm, *c*, closes the inlet aperture when depressed by a turn

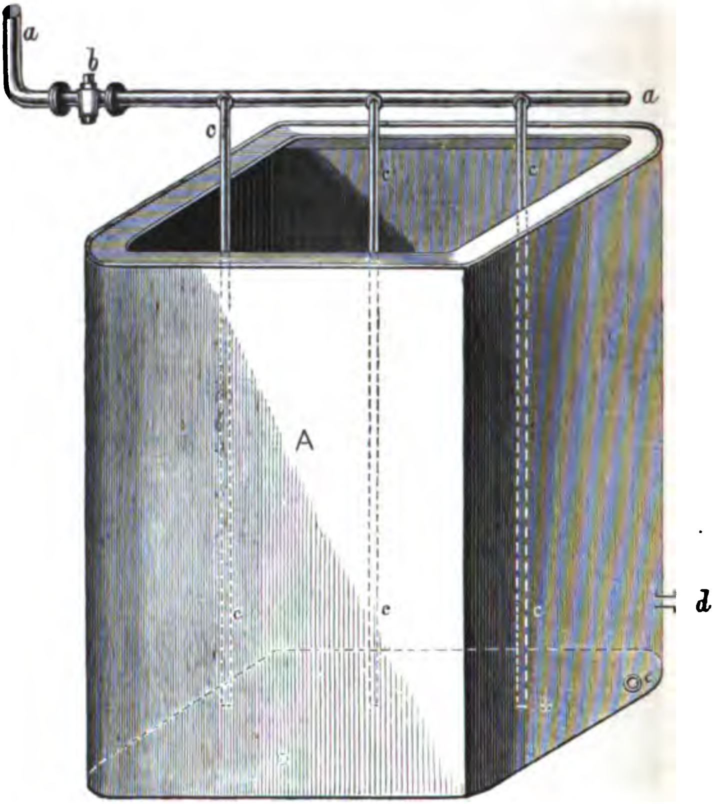

Fig. 31.—Scale of $\frac{1}{10}$th.

of the handle, *b*, which screws down the valve, *d d*. This valve, *d d*, consists of a screwed shank, a guide extending across the interior of the cover, *a*, to prevent it revolving when

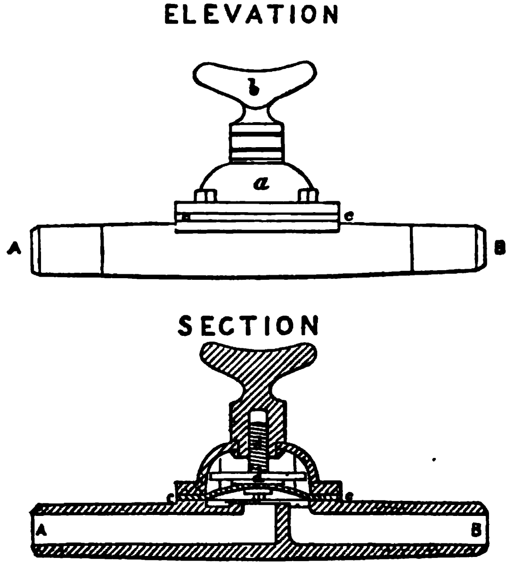

Fig. 32.

screwed down by the handle; a circular plate or valve on the upper surface of the india-rubber, and a loose washer or nut on the under-surface which allows the diaphragm to be replaced by a new one, when worn out.

In order to make the lye of requisite strength (specific gravity, 1·08 = 11° Baumé), 300 gallons of water are to be let into the reservoir, and 220 pounds of commercial "*caustic soda*" in small lumps added to it. Heat is evolved in the liquor at first, but after some hours' solution must be facilitated by a current of steam and occasional stirring with a wooden paddle. It is also necessary to stir when the solution is completed, in order to produce uniformity of strength throughout the liquor of the reservoir. The whole is left to repose for the subsidence of insoluble colouring matters and impurities, which latter must be drawn off from time to time, as they accumulate, through a very wide plug-hole, *o*, near the bottom.

Commercial caustic soda varies in strength from 75° to 60° of caustic soda, and must always be subjected to a test analysis. As the strength rises, the greater will be the purity; and even though the cost of the former may be higher proportionally, it is, all bearings considered, the cheapest and most convenient in the end. Therefore, always buy soda of strength as near 75° as possible.

The preceding formula for the preparation of the lye has reference to the employment of caustic soda of about that strength.

The lye being quite ready, 1200 pounds of amber-coloured rosin are put into the pan, with 2200 pounds of the lye, and motion and steam given to the twirl and pan. As heating and stirring go on concurrently, the rosin and alkali become a thick translucent homogeneous paste. At this point a sufficient quantity of hot water is let in gradually to thin the mass to semi-fluidity. Heating and stirring are to be continued until the paste becomes a thin jelly, and at that consistence, it is finished and ready for the frames.

Neither the strength of the lye nor the prescribed quantity should be altered, if the best results are desired, for they have both been adjusted according to the teaching of a long experience.

The product of this batch should be about 2200 pounds, costing 9*l.* per ton.

Its composition per cent. is—

Rosin	54·50
Soda (foreign salts)	7·80
Water	37·70
	100·00

Brooks, Day & Son lith.

Specially designed for Dr Morfit's Work on Soaps.

CHAPTER IX.

PALM SOAP.

In several of the preceding formulæ palm soap has been prescribed as colouring material. That made by the usual processes, and which may be bought of any soap manufacturer, is deep orange coloured; when its fat stock is, as it should be, unmixed natural palm oil. Sometimes, however, a soap of lighter shade may be required, and therefore the annexed formula is given for one of lemon colour.

Provide a wooden vat or tub with strong hoops and fitted with a tubular twirl like that shown by Plate XV. Into this tub put 1,600 pounds of unbleached palm oil, heat by means of the twirl to 120° Fahr., and then add 800 pounds of caustic soda lye * of 36° Beaumé, during constant motion of the stirrer. Care must be observed to keep the temperature of the mixture below 120° Fahr. and near 105° Fahr., so as to prevent any separation of the lye from the oil.

In two to four hours the saponification will be complete, and then the heating and stirring are to be discontinued, the tub covered well with a woollen cloth and left to itself. The temperature of the mass rises subsequently to 176° Fahr. At the end of several days the soap is ready for use.

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* This lye is made by dissolving 34 pounds of commercial caustic soda of 70° in 6½ imperial gallons of water.

CHAPTER X.

METHOD FOR "RUNNING DOWN" OR REDUCING THE COST OF OILMEN'S OR HOUSEHOLD SOAPS,

AS MADE BY THE ORDINARY METHODS WITH ROSIN AND EXCESS OF WATER.

THIS method has the advantage of replacing much of the excessive water with rosin soap, by which change the durability, economy and washing qualities of the soap are improved to the benefit of the consumer, without detracting from the large profit of the producer.

Take of the soap to be run down say 1,100 pounds, melt it in one of the pans, with water, to thin paste and then stir in, during constant heating, 500 to 550 pounds of rosin soap, as made in Chapter VIII. Care must be taken to add the latter by degrees, and to heat slowly until all probability of the pan's overrunning, from uprising of its contents, has passed; and, therefore, the use of the super-heater for these operations should be avoided.

When the mixed paste has become homogeneous and a sample tried on a glass sets firmly, it is ready to be dipped out into the frames, even though it may be still soft in the pan. The product should amount to 1,600 to 1,650 pounds. It will be ready in two days for cutting and is not only hard but will retain a clean surface permanently.

This process applies also to "extra pale" and "brown soap," but does not answer so well for "Primrose" soap. The "brown" may be "*run down*" more advantageously in every respect than soaps of a lighter colour.

The oleic soaps of my system are better

adapted for "running down" than all other kinds; but those made from thin "olein" will not bear more than half the prescribed proportion of rosin soap.

CHAPTER XI.

CRYSTALLISED GLYCERIN SOAP.

THIS formula was suggested by the "*Solidified Glycerin*" of Price's Candle Company, Limited,—a hard transparent soap of great emolliency, but so very hygroscopic that it becomes very wet upon short exposure. It is, therefore, sent to market in envelopes of tinfoil.

This soap is composed, according to my analysis, of

Fat (hard)	32·00
Soda	4·75
Water	21·75
Glycerin	41·50
	100·00

There is, therefore, the ratio of 14·85 caustic soda to 100 of oil, or an excess of 4·85; notwithstanding which the soap is practically free from all harshness. It does not, however, give a very rich lather, nor is it very emollient.

I have not been able to produce this soap of the composition above noted; but a superior article, with less glycerin and at less cost, may be made by my system, as follows.

It is an error to suppose that the emolliency of a soap will increase with the proportion of glycerin which may be put into it. On the contrary, glycerin itself, unless largely and skilfully tempered by proper associates, is more or less harsh to the skin. This is confirmed by the use of pure glycerin alone as a cosmetic, for a few weeks continuously.

Put into the pan 350 pounds of hot-pressed fat-acid cake (white), 150 pounds of inodorous light-coloured oleic acid, and 200 pounds of the whitest and best rosin. Heat to 300°—

310° Fahr., stir for three to five minutes, and then let in a boiling solution of 135 pounds of Jarrow carbonated ash (52°) in 25 gallons of water, at rapid flow. Continue the heating and stirring until the paste becomes perfectly homogeneous, or, in other words, about an hour, and then shut off the heat. At this stage, and while the stirring is continued, add 250 pounds of Price's or Sarg's pure glycerin. Take out half of the contents of the pan, and allow it to cool. If it is then transparent the soap is completed; otherwise it must be returned to the pan, and further treated with 125 pounds of glycerin in addition. The heating and stirring must now be regulated with great care, for sometimes the desired transparency is obtained by the stirring alone, and without further heating.

The better way to insure success and save possible waste of glycerin will be to take try-samples of about two pounds each from the foundation paste, and pre-treat them over the gas-flame with different proportions of glycerin. Then, on cooling, it can be determined from their appearance how it may be best to proceed with the whole cuite.

This soap is hard, very emollient, lathers freely, and does not sweat or become damp on exposure. Its composition, per cent., is as follows :—

Fat	34·00
Rosin	13·00
Soda (combined)	4·60
Water	15·40
Glycerin	33·00
	100·00

CHAPTER XII.

SULPHUR AND CARBOLIC SOAPS.

THESE soaps are nothing more than normal soap mixed with a portion of sulphurous matter or carbolic acid; and this system affords great facility for their manufacture in perfection.

SULPHUR SOAP.

The fat basis for the sulphur soaps should be a mixture of 600 pounds of hot-pressed fat-acid cake and 500 pounds of oleic acid free from empyreumatic odour. This is to be heated to 300° Fahr. and treated with a boiling solution of 212 pounds Jarrow (52°) carbonated ash in 45 gallons water, in the manner so often described in the preceding formulæ. The heating and stirring are to be continued for about ninety minutes, or rather until the paste is very dry and stiff. The sulphur is then to be diffused in hot water and gradually added during constant stirring without heating.

Precipitated sulphur, known commercially as "milk of sulphur," is the proper form of sulphur for this soap, but there is great difficulty in obtaining it free from adulteration. Sulphate of lime, or other earthy matter, is generally the debasing material, and its presence is revealed by a residual ash when a pinch of the suspected sulphur is burned upon a spatula of smooth fire-clay.

Sublimed sulphur, or flowers of sulphur, being pure and in fine powder, is the next best kind for this purpose, and it may be used in the proportion of 4 to 6 per cent., according as the soap may be intended for toilet or medicinal purposes. The proportion would be equivalent to 60 to 90 pounds for the whole cuite.

Sulphuret of potassium or sodium may be substituted for the sulphur, and in this case 5 to 10 per cent. of the solid salt may be employed; in other words, 75 to 150 pounds for the whole cuite. It must be dissolved in as little hot water as possible, and let into the dry and stiff paste gradually, during constant stirring and heating. When the paste, thus thinned a little at first, becomes stiff and dry it is ready to be shovelled out into the cooling frames and perfumed; for it is proper to remark here that this kind of soap is generally pressed into tablets of 2, 4, 6, and 8 ounces, after the manner of toilet soaps. Two per cent. of rosin with the fat would be a beneficial addition.

Sulphur soaps are used for man, horses, and cattle alike, as a medicated detergent in cutaneous affections.

CARBOLIC SOAP.

This soap is made both perfumed for toilet purposes and plain for general use, as an antiseptic and healing detergent for cutaneous affections, sores, or wounds. It is also good for washing the feet when they are disposed to smell badly, or become irritated by excessive perspiration.

As a household soap it is very efficient for keeping bedsteads free from bugs, and washing the clothes from sick-chambers. It is made in the usual way, but exclusively from hot-pressed fat-acid cake, on account of the tendency of carbolic acid to soften the paste.

Eleven hundred pounds of this fat stock are to be heated to 300° Fahr., and then treated with a boiling solution of 212 pounds Jarrow (52°) carbonated ash in 45 gallons of water, by gradual flow. When, after continuous heating and stirring for about an hour, the paste has become very stiff and dry, it is to be left to cool down for several hours, and then treated with 80 to 85 pounds of pure carbolic acid. This latter addition must be made in a thin stream and during constant stirring of the paste, but without any heating. When the whole is thoroughly incorporated, the paste is then ready to be shoveled into the cooling-frames.

Two per cent. of rosin may be added to the fat, at the time of heating it, in order to improve the suds or lathering property of the soap, and prevent any tendency to efflorescence.

This soap is also perfumed and pressed into toilet tablets.

CHAPTER XIII.

MANUFACTURING EXPENSE.

THE manufacturing expense will vary with the locality of the factory, and according to the difference in cost of rent, fuel, labour, and other items in different counties.

Here in England it was found, from actual experience in the factory at London, that the total expense would be covered by the following estimate. Of course, as many of the charges are unavoidably as great for a small as a large product of soap, it naturally follows that the manufacturing cost must fall with a rise of the quantity manufactured per month.

To determine the total cost of soap per ton, it is only necessary to add to the manufacturing expense, per ton, the cost of 13 cwt. of oleic acid and 2½ cwt. of Jarrow (52°) ash at the place where the soap may be made.

The item for incidentals will cover cost of boxes, though these latter are generally charged to the purchasers of the soap. Commercial expenses, such as discount and commissions on sales, being variable items, are omitted.

An estimate of the actual expense, per month, for working a factory at London, all charges, including delivery of the soap into the market, being comprised, is exhibited by the following Table :—

Items.	At Rate of 25 Tons per Month.			At Rate of 50 Tons per Month.			At Rate of 75 Tons per Month.			At Rate of 100 Tons per Month.		
	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*
Rent and Taxes..	21	0	0	21	0	0	25	0	0	25	0	0
Insurance	2	0	0	2	0	0	3	0	0	4	0	0
Water	1	0	0	2	0	0	3	0	0	4	0	0
Coal	8	0	0	12	0	0	16	0	0	20	0	0
Gas	1	0	0	2	0	0	2	0	0	2	0	0
Engineer	7	0	0	7	0	0	7	0	0	7	0	0
Foreman	7	0	0	7	0	0	7	0	0	7	0	0
Clerk...............	4	0	0	4	0	0	4	0	0	4	0	0
Laborers (2, 3, 5, 7)	9	0	0	14	0	0	20	0	0	30	0	0
Cartage............	5	0	0	10	0	0	15	0	0	20	0	0
Repairs............	10	0	0	10	0	0	15	0	0	15	0	0
Incidentals	10	0	0	15	0	0	20	0	0	25	0	0
Total Manufacturing Expense per Month ...	85	0	0	106	0	0	137	0	0	163	0	0
Total Manufacturing Expense per Ton	3	8	0	2	3	0	1	16	0	1	13	0

CHAPTER XIV.

PRACTICAL INSTRUCTIONS FOR THE CHEMICAL ANALYSIS OF SOAP.

THE most important point is to average the sample of soap fairly; and therefore the quantity for analysis must be taken from both its interior and exterior portions. One hundred grains being carefully weighed on the balance (fig. 3) are then placed in a beaker glass of two ounces capacity (fig. 33), and well covered with strong alcohol or methylated spirit; the whole is then heated on a sand bath, or in a water bath, until the soap is dissolved, and next filtered upon a paper of which a counterbalance has been made and preserved. The filtration is practised as shown by fig. 35, care being taken to select very porous or free-acting paper. When all the liquor has passed through, the residuum on the filter must be washed by pouring several portions of fresh and hot alcohol upon it. To prevent clogging of the filter, the liquors should be kept hot. The filter may be designated as A, and the filtrate or clear liquor running through into the beaker below as B. This last beaker should be tall and narrow, with a capacity of four fluid ounces, as shown by fig. 34, which, like fig. 33, is drawn to half

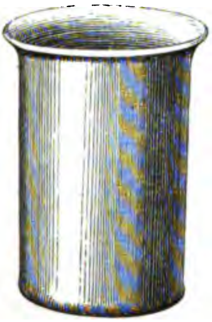

Fig. 33.

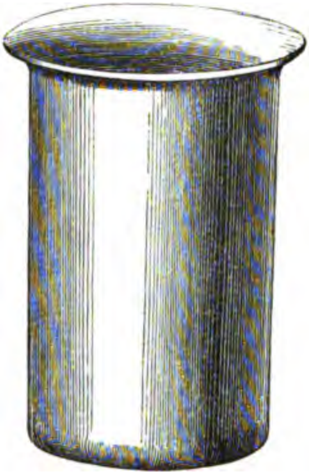

Fig. 34.

the natural size. The beaker, B, is put upon a sand bath, or into a water bath, in order that the contained liquor may lose its alcohol by evaporation. Previous to heating it, a fluid ounce of distilled water should be added.

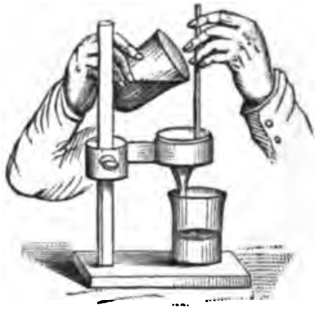

Fig. 35.

While this evaporation is going on, the filter, A, is to be placed in a porcelain dish and heated to perfect dryness. This state is known when the filter ceases to lose weight. The counterpoise filter-paper must be dried simultaneously, and put in the opposite pan of the balance, at the time of weighing. The constant weight expresses the per cent. of foreign matters, insoluble and saline, as well as of free alkali in the soap.

To determine the proportion of the latter, the weighed filter is put into a small beaker-glass, heated with distilled water, and then tested according to the directions given at pp. 65—71. The number of cubic centimetres of normal oxalic liquor required to redden a piece of blue litmus paper, previously placed in the liquor, will indicate the per cent. of *free* carbonate of soda in the soap. This, deducted from the original weight of the filter, will give the per cent. of insoluble and foreign saline matters.

By this time the filtrate, B, will have lost its alcohol, and is to be tested with normal oxalic liquor, according to the directions at pp. 65—71. The number of cubic centimetres of liquor required to redden the test litmus paper, indicates the per cent. of *combined* soda (NaO) in the soap.

This action of the acid at the same time separates the fat element and sends it to the surface of the liquor. To produce a more rapid clarification, a few drops of sulphuric acid should be added, after the neutralization with oxalic acid, and the beaker then set upon a sand bath to become hot. In the meantime 100 grains of beeswax are to be carefully weighed out and put into the liquor. The heating being continued, the wax melts and mixes with the fat. Stirring with a glass rod is necessary to promote this mixture. The beaker-glass is next removed from the bath into a cool place, in order that the wax-cake may set and harden. The glass rod being now drawn out, the subsident water is drained off from below and replaced with fresh boiling water, so as to melt anew the cake and wash it. On solidifying again, the cake is to be lifted out by the rod, placed between the folds of bibulous paper, and, after thus drying for twelve hours, weighed. The weight thus found, less that of the wax, denotes the per cent. of fat in the soap. The wax used for this purpose must be weighed from a portion which has been previously fused and cooled to free it from water.

The water is generally determined by drying 100 grains of very thin scrapings from different portions of the sample of soap, in a small platinum capsule, over either a sand or water bath, until weight ceases to be lost. Of course, the weight of the crucible must have been previously determined. Now, when the weight of the crucible and its contents of soap becomes constant after repeated heatings, during six to ten hours, this constant weight deducted from the original joint weight of the two previous to the heating, denotes a loss which is taken as the per cent. of water in the soap. But I have observed, invariably, in my experience, that however prolonged may be the heating of the sample, even at a temperature just within the degree at which it would decompose, there is still more or less of water retained, and amounting to several per cent. Indeed, it is only this portion of the water which can be considered strictly constitutional or chemical in the soap, for the latter may be made by my system with as low a proportion of water as several per cent. Practically considered, the proportion of constitutional water in soap is, however, twenty-seven per cent., even though the most of it may pass off by evaporation at warm temperatures. Indeed the soaps, as made by the ordinary methods, never harden except by loss of water through evaporation. Many kinds, even during transportation to the markets of southern countries, lose from one fourth to one half of their original weight in becoming dry, so variable is the amount of water, legitimate or fraudulent, which they contain on commencing their voyage.

Under all the circumstances, therefore, the more reliable way of estimating the water is to add together the figures obtained for all the other components of the soap, and deduct the sum of them from the weight of soap (100 grains) used for the analysis. The difference or loss may be taken as the per cent. of contained water. The results are to be arranged as follows:—

Insoluble, and foreign Saline matters..	
Carbonate of Soda, free	
Fat (and Rosin if present)	
Soda, combined	
Water	
	100·00

Having determined the composition of the soap, it yet remains to observe the consistence of the fat component, or rather the degree of temperature at which it congeals or fuses, this being an essential point in the economic and practical valuation of the soap for certain purposes. At the same time, any rosin that may be present can be estimated approximately.

A new portion of 500 grains of soap must be taken for these purposes, and being put into a tall beaker glass of about six ounces capacity, the exact weight of which has been previously taken and noted, is to be covered with boiling water and heated on a sand bath to solution. Diluted sulphuric acid is then to be added in slight excess, that is, until the liquor reddens blue litmus paper strongly. The solution of soap is thus decomposed by the acid seizing its alkali and sending the fat, or mixture of fat and rosin, to the surface.

On cooling the beaker glass and contents in iced water, the fat solidifies, so that it can be punctured by the glass stirring-rod ; and thus an opening is made through which the aqueous liquor beneath must be poured off. Fresh boiling water is now added to the fat, and the whole heated and cooled and drained of the wash liquor as before.

This operation being once more repeated, the beaker, now containing only the clean fat or mixture of fat and rosin, is to be placed on a warm sand bath, and heated until it ceases to lose weight, in order to drive off any water it may have retained. When the weight has become constant it is to be noted, and the weight of the empty beaker deducted from it. The remainder expresses the amount of fat. The beaker and contents must be cool when the weighings are made.

Having noted the weight, then add to the fat in the beaker about six times its weight of alcohol of 95° per cent. strength, heat in a water bath to solution, and pour in rather more of cold distilled water than is sufficient to double the volume of alcohol.

The fat immediately forms a separate stratum at the surface of the liquid, which latter then holds the rosin in a state of semi-solution, or rather of intimate suspension, if there was any contained in the soap, and thus assumes a milk-cloudy appearance.

By repose in a cool place, the fat stratum above sets hard, so that the rosin liquor beneath may be poured off. It is then washed by being heated with fresh water, and afterwards cooled and drained as before. It still retains some little water, which can be got rid of by leaving the beaker on a warm sand bath until it ceases to lose weight.

When, after repeated weighings, a constant weight is obtained, it represents the joint weight of the pure fat in the soap, and of the beaker, so that it is only necessary to deduct the figures for the beaker from the joint weight in order to get the amount of fat. This latter, subtracted from the weight previous to the treatment with alcohol, shows a loss which represents the amount of rosin. By dividing this latter by five, the per cent. is obtained, and on deducting it from the fat product as determined already in the 100 grains of soap, there remain the figures which express the per cent. of rosin in the soap.

In arranging the formula, then, the fat and rosin must be put down, in such case, as separate items, and not jointly as in the form just given at p. 245.

The final operation is now to note the melting point of the purified fat, and that is to be done according to the instructions already explained fully at p. 27.

CHAPTER XV.

LUBRICATING COMPOUNDS FOR RAILWAY USE.

THESE compounds do not belong strictly to the category of oleic soaps; nevertheless I consider it expedient to give a chapter upon them here, because the pan employed by me for the manufacture of the one is particularly suited to the convenient preparation of the other with the best results, and at the least possible expense in both cases. They are moreover articles of special utility, and largely consumed.

Locomotive Grease.

The grease for lubricating the axles of locomotives and railway carriages, being used in axle-boxes and for high velocities, must have considerable consistence, but not sufficient to let the axles get warm on account of a too persistent stiffness in the boxes. It must not be so soft, on the other hand, as to melt away rapidly.

The materials generally employed are tallow and palm oil associated with an aqueous solution of "sal soda" (crystallized carbonate of soda). In the following table by Watts and Richardson are given two formulæ which yield products that fulfil the necessary requirements of a good lubricator; that is they soften gradually into very thick cream, retain a low temperature until worn away, and leave no residue. The summer product will run 1200 miles. Allowing 2½ per cent. for loss, the amount of yield from the proportions prescribed is one ton.

For a winter lubricator, the minimum of fat is 25 per cent., to be increased to 35 or 40 for the warmest summer use.

Colza or cotton-seed oil may replace the sperm oil, but not without impairing in some little degree the excellence of the lubricator.

To make the grease, weigh out the fats, melt and heat them together in a wooden vat to 212° Fahr. by means of a current of steam, and then strain into the soap pan (Plate II. or III.) through a fine sieve in order to intercept all dirt and grit.

In the mean time place the sal soda and water into the feeder (Fig. 15) and heat to perfect solution at 212° Fahr. by means of a current of steam. Now apply motion to the stirrer in the oil, and at the same time let flow into it, gradually, and through a fine sieve, the soda solution. The stirring must continue at intervals until the mass is cold. The slower the cooling, the firmer will be the products.

Materials.	Winter Grease.			Summer Grease.		
	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.
Tallow	3	3	0	4	2	0
Palm Oil	2	2	0	2	2	0
Sperm Oil	0	1	7	0	0	27
"Sal Soda"	1	0	14	1	0	8
Water	12	3	12	12	0	26

Waggon Grease.

A lubricator of cheaper cost for common waggons going at low speed, such as are used in the goods traffic, is made with rosin oil (obtained by distillation) and lime. The rosin oil may be wholly or in part replaced by the heavier petroleum oils. This grease must be free from lumps, very smooth and rather tenacious of its water, so that it may be spread easily on the bare axle.

It is prepared without heat by stirring the strained oil in the pan and at the same time letting run in, through a *fine* sieve, a very thin milk of lime until the mixture begins to thicken,—say about fifteen minutes,—when the grease is to be run into barrels to "set" and solidify.

The proportion of lime varies with the oil, and must be determined by experience; but with care to guard against any excess lest the grease may become too hard.

Sometimes a grease free from water is required. In that case, the milk of lime must be allowed to settle in a vat, the supernatant water drained off, and the subsident paste of lime mixed with rosin spirit. This latter expels the residue of water, and sends it to the surface to be drawn off as before. The lime paste is next to be thinned out to a cream with more rosin spirit, when it is ready for use in the same manner as above described for the milk of lime.

Milk of Lime.

The preparation of milk of lime requires some skill, and in a regular manufactory there should be a special vat for the purpose.

This should be constructed, at a sufficient elevation, of brick and mortar lined with a coating of plaster of Paris or hydraulic cement. The form should be circular, with a depth of four feet and a width of three feet. These dimensions afford convenience for stirring and settlings. In the side, and at intervals of ten inches, commencing that distance from the bottom, five thick tubes of lead with wooden or india-rubber plugs are to be placed as taps for drawing off the milk of lime, as it may be wanted from different heights. These tubes must project six inches outwards beyond the wall of the vat to prevent slopping and waste during the drawing off.

The lime for all the manufacturing purposes of this treatise must be of the best kind, as free as possible from magnesia and other foreign matter, and perfectly caustic, or in other words freshly burnt. Having been spread over the bottom of the vat it is then drenched with sufficient water to cover it barely. In a few minutes it begins to swell and falls to powder, great heat and much aqueous vapour being developed; and hence the necessity of a vessel of masonry for the slaking operation. When the whole mass has become hydrated, that is either pulverulent or a soft pulpy mass, water is to be let into the vat, in greater or lesser proportion, according as the milk may be required thin or thick.

The whole must be stirred from time to time, and always just previous to a drawing off. This may be done with a hand rake, or better by a galvanized iron twirl properly geared and driven by steam power.

When a thin milk free from grit is required, much water must be used, so that the drawing off may be from the uppermost tap tube. On the other hand, for a thick cream much less water is to be added, and the drawing off must be from one of the lowermost tap tubes.

The stirring of the mixture of lime and water diffuses the former through the latter; but after a moment's repose the upper strata drop all the coarser and heavier particles into the lower strata, leaving the liquor near the top very smooth. Thus each stratum has a different degree of consistence.

By a prolonged repose the milk settles quite clear and forms a supernatant liquor of "lime water," which is a saturated solution of lime in water. Lime being more soluble in cold than hot water, nothing is gained by the use of the latter, except, perhaps, in the drenching operation, where it may hasten the hydration in some degree. At best, there are not more than 0·13 parts of lime taken up or dissolved by a hundred parts of water, even at 60° Fahr.

Richter's Table of the Quantity of Caustic Soda contained in Lyes of different densities.

Specific Gravity.	Soda p. Cent.	Specific Gravity.	Soda p. Cent.	Specific Gravity.	Soda p. Cent.	Specific Gravity.	Soda per Cent
1·00	0·00	1·12	11·10	1·22	20·66	1·34	31·67
1·02	2·07	1·14	12·81	1·24	22·58	1·35	32·40
1·04	4·02	1·16	14·73	1·26	24·47	1·36	33·08
1·06	5·89	1·18	16·73	1·28	26·33	1·38	34·41
1·08	7·69	1·20	18·71	1·30	28·16		
1·10	9·43			1·32	29·96		

Table exhibiting the Quantity of Fused Potassa in Caustic Lye, of different densities.

Sp. Grav.	Soda p. Cnt.	Sp. Grav.	Soda p. Cnt.	Sp. Grav.	Soda p. Cnt.	Sp. Grav.	Soda p. Cnt.	Sp. Grav.	Soda p. Cnt.
1·58	53·06	1·46	42·31	1·34	32·14	1·22	23·14	1·10	11·28
1·56	51·58	1·44	40·17	1·32	30·74	1·20	21·25	1·08	9·20
1·54	50·09	1·42	37·97	1·30	29·34	1·18	19·34	1·06	7·02
1·52	48·46	1·40	35·99	1·28	27·86	1·16	17·40	1·04	4·77
1·50	46·45	1·38	34·74	1·26	26·34	1·14	15·38	1·02	2·44
1·48	44·40	1·36	33·46	1·24	24·77	1·12	13·30	1·00	0·00

Poggiale's Table of the Specific Gravity Numbers, corresponding with Baumé's Areometric Degrees. For Liquids heavier than Water.

Degrees.	Specific Gravity.	Degrees.	Specific Gravity.	Degrees.	Specific Gravity.	Degrees.	Specific Gravity.
1	1·007	20	1·161	39	1·370	58	1·671
2	1·014	21	1·171	40	1·383	59	1·691
3	1·022	22	1·180	41	1·397	60	1·711
4	1·029	23	1·190	42	1·410	61	1·732
5	1·036	24	1·199	43	1·424	62	1·753
6	1·044	25	1·210	44	1·438	63	1·774
7	1·052	26	1·221	45	1·453	64	1·796
8	1·060	27	1·231	46	1·463	65	1·819
9	1·067	28	1·242	47	1·483	66	1·846
10	1·075	29	1·252	48	1·498	67	1·872
11	1·083	30	1·262	49	1·514	68	1·897
12	1·091	31	1·275	50	1·530	69	1·921
13	1·100	32	1·286	51	1·546	70	1·946
14	1·108	33	1·296	52	1·563	71	1·974
15	1·116	34	1·309	53	1·580	72	2·000
16	1·125	35	1·320	54	1·597	73	2·031
17	1·134	36	1·332	55	1·615	74	2·059
18	1·143	37	1·345	56	1·634	75	
19	1·152	38	1·357	57	1·662	76	

Table of the Mechanical Power of Steam.

Pressures.		Temperature in Degrees by Fahrenheit's Thermometer.	Pressures.		Temperature in Degrees by Fahrenheit's Thermometer.
Atmosphere.	Pounds per square inch.		Atmosphere.	Pounds per square inch.	
1·00	14·70	212·00	4·50	66·15	300·27
1·25	18·38	223·88	5·00	73·50	307·94
1·50	22·05	234·32	6·00	88·20	320·00
1·75	25·72	242·78	7·00	102·90	331·56
2·00	29·40	250·79	8·00	119·60	340·83
2·25	33·08	257·90	9·00	132·30	351·32
2·50	36·75	263·93	10·00	147·00	359·60
2·75	40·42	269·87	12·50	183·75	377·42
3·00	44·10	275·00	15·00	220·50	392·90
3·25	47·78	279·86	17·50	257·25	406·40
3·50	51·45	284·63	20·00	294·00	418·56
3·75	55·12	288·66	25·00	367·50	429·34
4·00	58·18	292·91	30·00	441·00	457·16

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